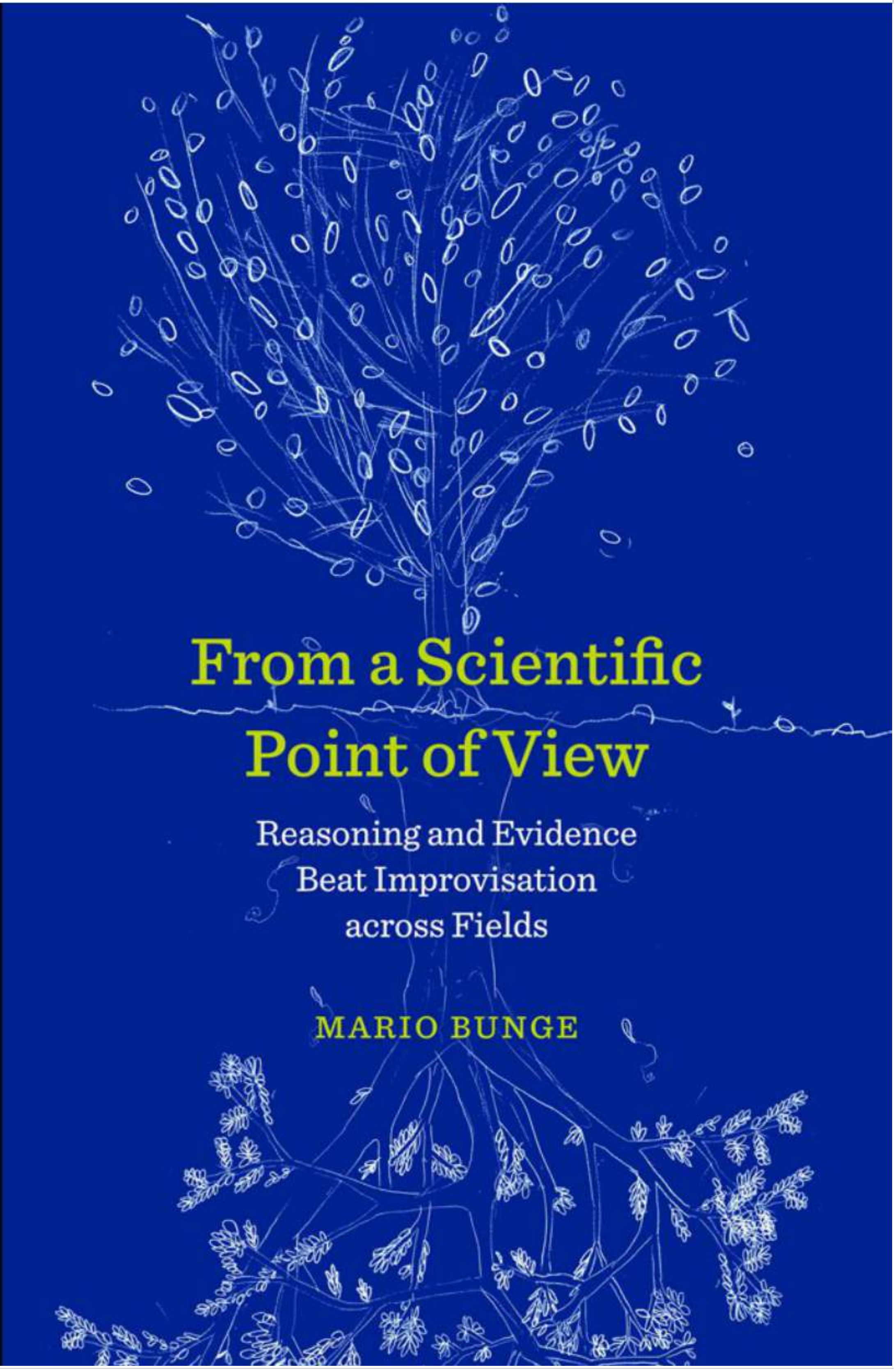

From a Scientific Point of View

Reasoning and Evidence Beat Improvisation across Fields

MARIO BUNGE

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By

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PREFACE

When dealing with a problem one adopts, explicitly or tacitly, some point of view or other – ordinary or learned, religious or secular, egocentric or acentric, practical or theoretical, dogmatic or scientific, computational or foundational, and so on. This book deals with the scientific point of view. Moreover, I will argue that this viewpoint can be profitably adopted in all fields, from agriculture to medicine, the law, management, policy-making, and even incarceration.

I will also argue that, though young and far from guaranteeing success, the scientific point of view is the best because it is the most demanding and the most open of all. Indeed, it shuns improvisation and freewheeling, demands argument and corroboration, encourages poaching on whatever discipline promises to be helpful, and solicits criticism, preferably of the constructive kind.

Last, but not least, the scientific point of view favors bringing science and technology close to philosophy, as it places problems and their proposed solutions in their broadest context – that of the most general and deepest assumptions about the world and our knowledge of it – and it endeavors to render philosophy more rigorous.

For example, the detection of gravitational waves in 2016 suggests replacing the subjectivist philosophies of space with Einstein's idea that space is a physical entity. And the worldwide rise in income inequalities, along with the cuts to public services, corroborates the epidemiological finding that human welfare, in particular health, depends critically upon economic security. Common sense suffices to understand that the ancient Roman saying *If you want war, prepare for war* is sheer folly. In contrast, the claim that the *liberty-equality-fraternity* political triad is weak unless it it rests on the *jobs-health-education* tripod is a solid result of the scientific approach to social issues. In short, science or bust.

1. The Scientific Worldview

Unlike seeing and hearing, which can be involuntary and unbiased, looking and listening are purposeful and can be biased. So much so, that sometimes we look or listen for something that may not exist, and that we tend to ignore impartiality (though not objectivity) in what matters most – health, human relations, and politics.

Worse, many a policy is designed from an unscientific point of view. For instance, most school principals and factory managers favor an early start of the schoolday or the working despite the strong finding that sleepy children are slow learners and fast forgetters, and sleepy workers tend to be clumsy and accident-prone (Walker 2017). Likewise, economic policies are usually designed in the light of bankrupt economic theories like monetarism, or even ideological slogans, rather than sound economic research, with dire consequences for the economy and public services. Thus Alan Greenspan, who designed the American monetary policies during two decades, followed the advice of his mentor Ayn Rand – the pop philosopher and champion of right-wing libertarianism – and favored the further income inequalities that harm everyone under the top one percent (Stiglitz 2012).

Outlooks or points of view are supremely important in all fields because everything is looked upon or thought about from some viewpoint or other – objective or subjective, religious or secular, vulgar or learned, sophisticated or simplistic, theoretical or practical, critical or dogmatic, scientific or unscientific, and so on.

These and other points of view or stances are mutually inequivalent and often incompatible with one another. For example, the scientific and the religious stances are mutually incompatible, even though religious believers can do good science provided they check their dogmas at the door of science. Overall consistency is desirable but hard to attain. Thus Niels Bohr, the grandfather of quantum physics, is said to have kept a horseshoe above the door to his country cottage, claiming that it was supposed to bring luck even if one did not believe it.

To acknowledge the adoption of a viewpoint is not the same as placing the inquiring subject at the center of the world, the way Berkeley, Kant and the positivists did. It is just to remind ourselves that, although the world did not wait for humans to emerge, *pace* Popper (1972), there is no

knowledge without a knowing subject. In other words, objectivity does not demand obliterating the subject, but only abstaining from including an image of the artist in one's picture of the universe (Rescher 1997). If scientific, a worldview will not assume either that the universe is ego-centered or that some supposedly holy writ contains all there is to be known.

All the ancient Greek philosophers, from the pre-Socratics to Aristotle, held worldviews or *Weltanschauungen*, that is, comprehensive conceptions of the cosmos and man's place in it (see Aerts *et al*. 1994, Dilthey 1911, Bunge 1993, Duhem 1913-59, Matthews 2009, Rescher 1985). Suffice it to recall three of the most influential ones in antiquity, namely Epicurus', Plato's, and Aristotle's – all of them conceptual, secular, and impersonal. By contrast, most modern philosophies have been subject-centered as well as suspicious of ontology, and thus indifferent or even hostile to the very idea of a worldview or "grand narrative", as Jean-François Lyotard (1979) called it contemptuously in his postmodernist manifesto.

In particular, phenomenologists call themselves *egologists* for they, like St. Augustine, were inward-looking and therefore disinterested in cosmological matters. Likewise pragmatism, centered as it is in human action, as well as ordinary-language philosophy and French postmodernism, are glossocentric or word-centered. For example, the French postmodernists call politics *le discours politique*, or the political narrative – which suggests that they conceive of politics as a purely verbal contest.

As is their wont, most philosophers study worldviews in themselves, whereas anthropologists place them in their social settings. For example, the kind of job affects behavior and belief in the Chinese districts where different kinds of agriculture are predominant (Talhelm et al. 2014). Growing rice, which is predominant in Southern China, requires people to work in crews. This occupation fosters cooperation as well as consideration for the coworker, and sustains a holistic worldview. In contrast, growing wheat, which is the main cultivar in Northern China, can be done by individuals or couples, and it goes together with an individualist worldview. In short, worldviews tend to match lifestyles.

Typically, doing philosophy is a solitary occupation, whereas doing science calls for teamwork or at least discussion in seminars and journals. The record for scientific collaboration was set on August 17th of 2017, when the collision of two neutron stars that occurred 130 million light-years away and produced a short but intense burst of electromagnetic radiation was studied by 3674 astrophysicists from 953 institutions (Cho 2017).

Unsurprisingly, me-centered doctrines have flourished only among philosophers. Three examples come to mind: classical empiricism, Kantianism, and logical positivism. All three are egocentric since they focus on phenomena (appearances) and our study of them, and consequently are disjoint from all worldviews. In the present book I will argue that scientific research presupposes a worldview, namely that of science, which is acentric, in particular impersonal or objective, as well as genderless and nonracial.

The vague and somewhat suspect notion of a viewpoint or approach may be elucidated as follows. An approach A to a cluster P of problems consists in dealing with P in the light of a worldview W, in accordance with a certain method M, and in view of a definite goal G. In short, $A = \langle P,W,M,G \rangle$.

Different choices and combinations of those four items will yield different kinds of approach. We are particularly interested in the following kinds of approach:

ordinary if no expertise is involved in learning either P, W, M, or G;

scientific if the problems concern knowledge, the worldview is plausible in the light of the scientific background, the methods are duly checked conceptually or empirically, and the goals are both attainable and disinterested though nontrivial. If any of these conditions fail to be satisfied, as in the cases of navel gazing, intuitionism and hermeneutics, the approach will be deemed to be *unscientific*;

technological if its problems or issues are practical, the woldview scientifically plausible, the methods reliable, and the goals practical or utilitarian;

moral if the problems concern the welfare or the rights and duties of others;

political if the problems concern the rights and obligations of the citizens or the governance of the commonwealth;

philosophical if the problems transgress disciplinary divisions, the worldview is comprehensive, the methods purely conceptual, and the goals are clarity, depth, or systematicity.

If the problems to be studied are either bogus or narrow, the worldview absent or wild, the method esoteric or consists in verbal juggling, and the goals are to support an ideology or just to pass off extravagance for originality, then the approach deserves being called *pseudophilosophical*. Existentialism is the perfection of this genre. In particular, the existentialist dicta are either trivial or nonsensical, so that they do not help solving any problem other than meeting the grocer's bills. Suffice it to recall Heidegger's claims that "Time is the maturation of temporality," and "The essence of truth is freedom."

Note that every one of the six approaches listed above can be practiced in more than one way – for instance, by adopting different methods, or with somewhat different goals. In particular, the scientific viewpoint is consistent with both reductionism (or single-level ontology) and emergentism (or multilevel ontology).

Scientism is not the same as reductionism, in particular the attempt to reduce wholes to their parts (microreductionism) or to higher-order entities (macroreductionism). Both strategies have worked in a few cases, but have failed in most. For example the magnetism of an iron bar is explained as the alignment of the magnetic moments (or spins) of the individual iron atoms; and social psychologists have explained certain individual inclinations or preferences in terms of the individuals' positions in social groups such as classes or ethnicites, but have ignored key individual traits such as curiosity and creativity, whereas the fashionable rational choice theories, such as those of decision and game, have failed in attempting to account for large-scale social processes such as economic slumps and wars.

Most reductionist attempts have failed because they have ignored the emergence and submergence of properties that accompany the agglomeration of individuals as well as the disintegration of wholes, as in freezing and liquefying, marriage and divorce, recruitment and demobilization. Families, firms and armies have global properties that their components lack. Optics does not explain colors because these occur only in brains, which are very special living organs. And material entities, or "its", are not bundles of "bits", or information-theoretic units, because the latter have no physical properties and occur only when analyzing information-processing artifacts. In short, the design and assessment of scientific research projects and their products should not ignore the existence of different levels of organization – microphysical, macrophysical, chemical, biological, microsocial, and macrosocial (see Bunge 2003a).

The scientific stance is characterized by a modicum of philosophical awareness along with curiosity, disciplined imagination, cogent argument, the search for pattern and evidence, and moderate or partial skepticism. It

is thus the opposite of dogmatism, in particular authoritarianism and radical skepticism, or the questioning of everything at the same time. A moderate skeptic will question item *A* on the strength of *B*, which in turn can only be questioned by assuming *C*, and so on. There is no presuppositionless inquiry, for the very statement of any problem takes some assumptions or data for granted.

For example, biologists take mathematics and chemistry for granted. And although philosophers are not competent to criticize particular physical findings, they should be able to spot and question some philosophical assumptions of physicists, such as the operationist definition of time as whatever timepieces show. In short, scientific skepticism is not total but partial and stepwise.

Notice that there are two kinds of moderate skeptics: those who admit, and those who reject the possibility that science may eventually tackle and solve certain problems, notably those of the existence of God and of consciousness.

The former are prepared to listen to arguments purporting to confute theism, or to prove the occurrence of conscious mental processes.

Since belief in the supernatural is a belief among others, a scientific account of the formation and spread of beliefs should settle the question of religious beliefs as so many human inventions. In fact, a branch of scientific psychology deals with beliefs both grounded and groundless (see e.g. Alcock 2018). In particular, religious beliefs are being studied scientifically, whereas any religious approach to science is bound to shrink or distort it, for it admits the existence of a supernatural and omniscient being that we cannot fully conceive of.

It is also well known that expertise in a given scientific field is compatible with religious affiliation. For example, Christians can do excellent work in chemistry – though perhaps not in cognitive neuroscience, anthropology, or history. The belief in the superiority and universal appliccability of the scientific point of view is called *scientism* (Schöttler 2013, Bunge 2017).

As for consciousness, let us start by admitting that it comes in several varieties (Bunge & Ardila 1987). These various concepts of consciousness share the idea that a subject experiences a conscious mental event whenever she thinks of it. In a cognitive neuroscience perspective, a subject is conscious whenever one part of her brain monitors what goes on in another part of it (Bunge 1980: 174-181). An electric network's voltmeter, a car's dashboard and a steam engine's Watt regulator are similar. But of course radical skeptics or mysterians, like Noam Chomsky (2009), will repeat the old dogma that mind and matter are and will always

remain mysterious, just as the International Flat Earth Society keeps admitting new members. Meanwhile, both conscious and unconscious mental processes are being successfully investigated by psychologists (e.g., Edelman & Mountcastle 1978, Dehaene *et al*. 2017).

The scientific stance is compatible with the technological and philosophical viewpoints, to the point that sometimes it is indistinguishable from them, as in the cases of experimental ethics and general systems theories. The scientific stance is likely to elicit the hostility of the "humanistic" or hermeneutic psychologists and social students tied to the armchair (non-experimental and non-mathematical) approach typical of literary studies, such as the Wittgensteinian Peter Winch (1958), who denied the very possibility of a social *science*.

The scientific stance is particularly unpopular among the gatekeepers of the humanities. Thus, the philosophy editor of the most prestigious American university press stated clearly his preference for submissions that reject a mode of thinking that "quantifies and commodifies the world around us to the exclusion of spiritual values." Presumably, he would reject any social studies using the UN human development index, while buying speculations by armchair social students belonging to the Frankfurt school (or "critical theory"), French structuralism, or hermeneutics.

The explicit and consistent adoption of the scientific viewpoint is bound to affect numerous choices and decisions in all fields. For example, scientifically minded people will be skeptical about alleged cases of telepathy, clairvoyance, precognition, ghosts, psychics, zombies, spoon bending at a distance, haunted homes, and the like. Some skeptics will try to reproduce them in a laboratory, explain why some people are more gullible than others, or even why some people seem to need belief in such fantasies (see, e.g., Alcock 1981, Randi 1980).

For instance, in 2011 a psychology professor retired from Cornell University claimed that, if properly trained, ordinary children can acquire precognition, that is, the paranormal ability of seeing the future (Bem 2011). The proscience debunkers reacted immediately, holding that brains cannot feel effects before their causes for, if they could, the individuals with that ability would be able to act so as to affect the future – for instance, by preventing it from causing such extraordinary phenomena.

The psychological community recently heaped scorn on the otherwise reputable journal that published a piece on precognition, and vowed to strengthen the prevailing standards of scientific rigor. It is not enough to criticize published errors: gatekeepers should try and prevent serious errors from being published, by using scientificity criteria, such as

compatibility with the bulk of current science, or by demanding corroboration by an independent research team.

The scientists who search for extraterrestrial intelligence (SET) belong to an utterly different kind. They neither assert nor deny the existence of "aliens": they just search for signs or indicators of life in one of the many planets beyond our solar system discovered since 1992. The estimates of the probabilities of their existence, such as Drake's formula, are purely speculative, but it is generally hoped that some organisms will eventually be found in some galaxy or other. This hope rests on the abiogenesis hypothesis, according to which the earliest organisms emerged spontaneously eons ago from ordinary molecules, and were subject to evolutionary forces, chiefly mutation and selection. This problem is the subject of *The Origin of Life* journal, which has been published since 1968. This journal will reject wild speculations but will admit sound ones. (See Bunge 1983c for the difference between wild and sound speculations, and Bunge 2011 for the notion of bogus knowledge.)

In contrast, the belief in intelligent design is typically unscientific because it assumes the existence of a supernatural creator, whereas evolutionary biology is a strictly secular discipline dealing with spontaneous biosynthesis, mutation, and natural selection (Ayala 2010). A first step in the creation of life in the lab was the synthesis of the first complete gene, a yeast tRNA, achieved in 1972 by Har Gobind Khorana and coworkers. Several companies are selling gadgets to manufacture genes of various kinds by just mixing a number of inorganic precursors: the synthesis process starts and proceeds spontaneously. No *élan vital* (vital spirit) or *Bildungskraft* (constructive force) guides such synthesis. Contrary to Plato's belief, that only the soul is *autokineto*, matter is anything but passive. For example, planets do not need to be pushed by angels. Not in vain, the core statements of scientific theories are equations of motion, reaction equations, and evolutionary change formulas, none of which refer to supernatural agencies.

Scientific findings are expected to be original, yet compatible with the bulk (not the whole) of the extant scientific knowledge. Breakthroughs, even revolutions, do occur once in a while in every discipline, but none of them involve the revision of all the previous knowledge in the same field. For example, the discovery of compounds of "noble" gases like xenon was unexpected, but quantum chemists eventually explained it. Likewise, the discovery of toolmaking crows suggests dropping the definition of "human" as "the tool-making animal," but has not removed toolmaking from the list of traits jointly peculiar to our kind.

The scientifically minded person is neither a know-it-all nor a radical skeptic or know-nothing: she seeks plausible answers to interesting questions, trusts only scrutable methods, and keeps trying until hitting on what looks correct in light of the extant knowledge – which may be corrected by further research. In other words, she is a seeker but not a seer, and fallibilist but not defeatist. Further, she is not content with refuting errors, but hopes for new findings.

While some findings of scientific research are final solutions to some problems, others are approximate solutions, and still others are unexpected new problems. Consequently, as it enriches our fund of knowledge, scientific research also poses fresh problems. These features of science suggest replacing the classical definition of knowledge as "warranted true belief" with the description "mixed bag of data and researched approximate truths."

The same features also guarantee that, far from being a closed system like the religions and political ideologies, scientific research is a self-sustained process with new challenges and thus new discovery adventures. This is the only guarantee one should expect from adopting the scientific stance: that it will never cease to generate new jobs in the knowledge industry.

In this book I argue that the scientific stance can be profitably adopted in all the fields of inquiry and action, from physics to pharmacology to political science, policy design, and philosophy. This is of course the scientistic program (Bunge 2017a).

Consider the following five "hot" cases

1/ *Language*. The dictionary informs us that language "is the method of human communication." By contrast, the grammarian Noam Chomsky (2016) has always contended that language is primarily a window on the soul and an instrument of thought. Which of the two views is true or, rather, the truer? Whereas the dogmatist will accept one of them without further ado, the scientifically minded person is likely to ask for evidence in support of either thesis. Further, the skeptic may end up by suggesting a third hypothesis, namely, that (a) the primary function of language is communication, as suggested by personal experience as well as by sociolinguistics and primatological studies, and (b) its secondary function is to help thought processes, in particular the weighing of mutually inconsistent opinions and the refinement of intuitive or preanalytic ideas. See more on this subject in chapter 9.

2/ *Disease.* On feeling sick, I consult a friend who offers a diagnosis and even a treatment, as it worked for her as well as for a neighbor. But I am a tad more sophisticated, and consult the Mayo Clinic's big blue book. Sure enough, I find that my symptoms fit a certain disease; but a further search in the same volume suggests several other candidates. So, I ask for a hospital appointment, and get a diagnosis and a prescription. To make sure, I consult the medical literature to see whether the treatment I have been prescribed has passed randomized controlled trials. It has, but I am not feeling better. So, I continue to search the literature until hitting on John Ioannidis's (2005) pessimistic evaluation of the recent biomedical literature. Still, I do not give up, because I am confident that someone, somewhere, is studying my problem in a scientific manner – the only game in town according to the scientistic credo, which I happen to profess (Bunge 2017).

3/*Tropical forests: Carbon sinks or sources?* Until recently it was believed that forests are carbon sinks, whence the need to regulate logging. A recent study of satellite data about American, African and Asian tropical forests gathered over 12 years, has reversed that assessment: tropical forests are a net carbon source (Baccini and 5 coworkers, 2017).

Consequently the forest management policies, as well as the emisssion reduction targets, have to be revised. But it would be foolish to regard the new result as a license to keep deforesting, since trees serve us in many ways, in addition to participating in the carbon cycle; for example, they fix the soil and thus reduce landslides, and are homes to aboriginal populations.

4/ *Rich/poor gap.* Income inequalities have been rising everywhere since around 1960, to the point that the fabled American Dream, of going from rags to riches through hard work in the free market, is just that (Chetty et al. 2017). Two different strategies have been tried to cure this social ill – the mother of all social issues according to Rousseau. One is government intervention to either mediate or side with one of the two parties – managers and workers. The other strategy is to use union power, that is, collective bargaining, picketing, and strike. Both methods have worked in some cases though with decreasing frequency, either because of intransigence or because the unions have been betrayed by their leaders, rejected by management, or even outlawed. (Only 7% of the American workforce is unionized – exactly one-tenth of the corresponding figure in Sweden, Denmark, and Finland.)

A scientific approach to the inequality issue might conclude that the conflict itself should be avoided, by favoring the transformation of private firms into cooperatives, where workloads and compensations are discussed and determined democratically by the membership – unless the business in question is either a family concern or a public utility – in which case it behooves the state to manage it, and the public to fund it through fair taxes (see Bunge 2009).

In short, the scientific approach, once wrongly touted as the panacea for all cognitive issues, is currently under attack by postmodern writers and self-styled liberal policy makers. For example, in the midst of a severe epidemic of opioid prescription and dependency, some of the big pharmaceutical firms have discontinued research on nonaddictive analgesics just because the sales of opium-based pain-killers are profitable enough (see, e.g., Nemirowski 2011). Likewise, the denial of man-made global warming, and of the benefits of public education and health-care, ignore the scientific study of such issues, and favors the vote-gaining improvisations of populist politicians.

We are currently witnessing a quick return to the obscurantist attitudes that prevailed before the 1750-1950 period, when in the West the scientific stance prevailed over its antagonists. Scientism, once proud and ruling in Western culture (Schottler 2012), is now retreating in spite of its triumphs in all fields but politics, the one area where ignorance can pass for wisdom, selfishness for rationality, and brutality for strong leadership.

To sum up, the scientific stance has led to many a victory in the struggle for enlightenment and welfare. However, let us face it: public trust in that stance has weakened in recent years in several advanced nations, where regressive ideologies have replaced the researched ones.

5/ *Earliest Americans.* According to conventional wisdom, humans arrived in America, most likely from Siberia, about 13,000 years ago. The recent discovery of the Cerutti Mastodon site in Southern California (Holen, Deméré et al. 2017) may be evidence for the hypothesis that the earliest humans arrived in North America far earlier, namely 130,000 years ago. That site contains hammerstones and anvils from mastodon limbs for marrow extraction. These possible artifacts were found and studied by a team of eleven paleobiologists and earth scientists working at reputable universities and museums in the USA or Australia. They used some stringent criteria, from site dating to interdisciplinary means, to examine over 300 fossil mastodon bone fragments, some of which suggest percussion-fractures, as well as blows and abrasive smoothings suggestive of manual dexterity.

This finding shocked anthropologists. But enthusiasm should be tempered by the failure to find human-like remains, stone tools, and other artifacts, such as fireplaces. At all events, the ongoing debate is not about raw data but about how to "interpret" them. It is thus an unsettled methodological issue. But at least we know what would solve it, namely finding distinctly human fossil bones along with indisputable artifacts such as scrapers and firepits. Thus, this philosophical debate would be won or lost by the scientists who made the bold jump from mastodon to man. And it would earn them prestige or regret but neither riches nor power. Hence the philistines, now on the rise worldwide, would at best remain indifferent.

6/ *Psychology and social studies: humanistic or scientific?* Ernst Weber (1851), Gustav Fechner (1860), and above all Wilhelm Wundt (1879) transferred psychology from its humanistic (or non-empirical) cradle to experimental and mathematical science. Nowadays only psychoanalysts, phenomenologists and followers of the Frankfurt "critical theory" school publish *a priori* speculations about mind and social behavior. Fortunately, these unscientific opinions are seldom taken seriously in the corresponding scientific communities.

7/ *Effectiveness of social programs.* How effective are the social programs aimed at palliating the stark inequalities in American society at the price of more than US$ 5 trillion a year? Nobody knows (Mosteller 1981). The same holds for gun-control laws: we still do not know whether they work (Cook & Donohue 2017). Why such ignorance? Because such programs and laws have been designed, fought over and assessed by vote-hungry politicians, not by experts in social technologies such as policy-making, law, management science, education science, and social work. In particular, the question of whether unemployment compensation discourages or helps the search for jobs was handled in ideological terms until Biegert (2017) subjected the relevant data for 20 European countries and the United States to a scientific analysis.

8/ *Free-trade vs. protectionism.* The free-trade policy is a key component of the traditional ideology abetted by the exporting countries like Great Britain. Only a handful of economists defended protectionism (high tariffs on manufactured goods) to allow industry to emerge and develop in the developing countries. In the USA, protectionism raised its head only in the 2016 presidential elections, when even Hillary Clinton expressed "reservations" about the free trade agreements signed earlier by her

husband Bill, one of the most enthusiastic champions of free trade, which he praised as the universal key to prosperity. With very few exceptions, the economic professors were not available for comment. None of them explained the turnaround of the political guruship as a late realization that the main beneficiary of free trade had been China. The strategists of the most powerful empire in human history might have foreseen this momentous event if they had adopted a scientific stance when reviewing international trade.

9/ *Post facts and post truth?* The self-appointed sociologists of science Bruno Latour and Steve Woolgar gained instant celebrity in 1979 when they claimed that their study of "science in action" proved that facts are social constructions, whence truth is illusory. Their research consisted in observing the operations of some experimental workers whom they could not understand for lack of a scientific background. They only perceived that their subjects looked, made inscriptions, and engaged in gossip during coffee breaks. A fortiori, these self-appointed explorers of "science in action" could not understand the final products of such mysterious activities, namely papers in specialized journals. Being unable to understand anything beyond some fragments of overt behavior, they concluded that scientists made up the facts they claimed to study. For example, the ancient Egyptians could not have suffered from tuberculosis, because Robert Koch made up the corresponding bacillus only in 1882. This outrageous opinion, known as constructivism-relativism, was criticized by some scholars (e.g., Bunge 1999), but it took Latour (2017) nearly four decades to own that this dangerous nonsense had been among his *peccata juvenilia*, and that science should be accorded some authority after all.

10/ *Is scientific philosophy possible?* Philosophy and science were one until about 1700, when Berkeley, Hume and Kant divorced philosophy from science, and most universities were divided into two separate bodies: science, and arts or humanities. Science and philosophy merged again around 1850, when a handful of scientists and science enthusiasts introduced the so-called crass or vulgar materialism, which rejected both Kant's phenomenalism and Hegel's dialectics, but exaggerated the reach of Newtonian mechanics. Friedrich Engels (1878), Marx's coworker, criticized them for ignoring dialectics, and advertised his own materialist reworking of Hegel's system as scientific. Regrettably, Engels was not much interested in empirical corroboration, and wasted his considerable talents criticizing minor thinkers like Eugen Dühring. At about the same

time, Charles S. Peirce – who, unlike Engels, had a solid scientific grounding – wrote about scientific metaphysics, but did not advance beyond a few programmatic observations. In the first half of the 19^{th} century Edmund Husserl (1995: 31) proposed his own phenomenology or egology as "the universal rigorous science" and also as "the most extreme opposite of the objective sciences." Why should scientists pay any attention to this outspoken antiscientific stance?

The mathematicians, scientists and philosophers who gathered in the Ernst Mach Verein, or Vienna Circle (1929-1933), built logical empiricism, also called logical positivism, which claimed to be congruent with both contemporary science and the new logic. However, their influence was restricted to the theoretical physicists who mistook observers for reference frames – hence read 'relative' as 'subjective' and 'existent' as 'observable.' Their ambitious project failed because they preferred phenomenalism to realism, and claimed to have overcome the materialism/idealism chasm. Incidentally, let us remember that phenomenalists hold that everything *seems* but nothing *is*. By contrast, scientific realists believe that some things are; that appearances emerged only along with the earliest sentient beings; and that only scientific research can reveal the existents beneath phenomena, such as the water molecules released by the washing while drying under the sun. As for the nature of the mental, whereas idealists hold that it is immaterial, materialists maintain that mental processes, such as perceiving, computing, and awareness of self are brain processes – as revealed by cognitive neuroscience.

The scientific philosophy project was recovered a few decades later by the present author (Bunge 1974-1989). This program kept rationality and concern for corroboration, but replaced egocentric phenomenalism with hylorealism, a synthesis of realism with materialism. There will be more on this in the last chapter.

2. SHOULD SCIENTISTS LISTEN TO PHILOSOPHERS?

It is well known that most scientists have little patience with philosophical issues – unless they themselves do philosophy on the side, as Einstein (1934) and a few others did. Let us try to find out why.

1. The Hume cult

The vast majority of contemporary scientists claim that experience, from sensing to acting, and from observing to experimenting, is the alpha and omega of human knowledge. This epistemological principle is the center of empiricism, one of the grand philosophical traditions in both Indian and Western philosophy, along with idealism and materialism. It was introduced and discussed in 600 BCE by the Charvaka materialist and empiricist school (Dragonetti & Tola 2009). In the West, the most popular version of that principle is British empiricism, whose heroes were Francis Bacon, John Locke, and David Hume.

Bacon's influence during that period was such, that the Royal Society of London was founded in 1662 to put into practice his project of discovering and describing all the things in the world with the sole help of the senses. His prestige was such that even Newton, who owed him nothing – since his *Principia* was hypothetico-deductive rather than inductive – declared that his great work owed him everything. And Charles Darwin, who confided to his notebooks his contempt for Locke, in his autobiography declared his adherence to inductivism, apparently to protect his science from attacks by the upholders of the ruling philosophers.

Empiricism is still very popular. An opinion poll published in 2013 revealed that David Hume is nowadays the philosophers' favorite philosopher of all times, at least in the anglophone world. Hume himself might be surprised at this finding, since only one of his many books, namely his *Enquiry* (1748), was properly philosophical. Moreover, this work was neither successful nor very original, for it only elaborated in great detail the scholastic principle *Nihil est in intellectu quod prius non fuerit in sensu* – or "All concepts descend from percepts." (See a detailed analysis in Bunge 1959a.)

Modern science, from physics to biology to historiography, has bypassed that principle, as may be gathered fom the ubiquity of "zero", "atom", "universe," and "history." Hume may have realized this, for he attacked Newtonian mechanics, the earliest successful scientific theory in history, despite ignoring the mathematics required to understand it. Hume disliked Newtonian mechanics for containing such nonempirical concepts as those of mass, inertia, and action at a distance, and for formalizing such counter-intuitive models as the heliocentric view of our solar system.

The scientific stance is currently being attacked as vehemently as ever. The German idealist Wilhelm Dilthey (1883) wrote the popular manifesto of the "humanistic" school, where he postulated – against the "spirit of the time" – that human beings are essentially spiritual, and as a consequence could only be understood by putting oneself in their shoes – a procedure he called *Verstehen*, variously translated as interpretation, empathy, and intuition. For instance, one may understand Napoleon's attack on Russia as being fueled by his ambitions, which so far had been gratified. But this does not explain why he was able to recruit his Grande Armée, let alone why it suffered a crushing defeat. Cold weather, food scarcity and guerrilla attacks play no role in the hermeneutic or interpretive approach to large-scale social facts.

The sociologist Max Weber called himself a follower of Wilhelm Dilthey. When he commissioned a study of the Polish guest workers in Eastern Prussia, Weber had the choice between physicians and priests as primary data providers (Lazarsfeld & Oberschall 1965). Weber reckoned that the former would report on the state of health of the agricultural workers, whereas the priests would presumably report about their spiritual concerns – even though his informers were unlikely to share the religion or the language of their subjects. Obviously, in this case – one of the few projects Weber undertook that required empirical research – he adopted the unscientific stance inherent in German idealism (Bunge 2007).

A cynic noted long ago that philosophy is where science goes to die. Indeed, Hume's empiricism, which played no role at all in the making of modern science, exerted an enormous influence on philosophy. Suffice it to recall Berkeley, Kant, and their two main offsprings: positivism from Comte and Mill to Mach, and the logical positivists – phenomenalists all of them and therefore allergic, at last initially, to the very idea of matter, in particular imperceptible matter, be it corpuscular or field-like.

Around 1800, positivism had become so ingrained in the scientific community, that even some eminent scientists parroted a scientific methodology that they did not practice, namely the one according to which scientists always start by making observations, and proceed to condensing

them into inductive generalizations, which are subjected to tests in order to attain certainty. Even now, after the sensational success of highly sophisticated theories, such as quantum mechanics, most people think that scientific theorizing consists only in data fitting, or the compression of a bunch of empirical data into a polynomial – a task that may be assigned to a computer. This view is called *inductivism*.

True, Whewell, Peirce, Poincaré, Meyerson, and Popper criticized inductivism using historical counterexamples. But they did not disprove it, did not say where hypotheses come from, and did not analyze any experiments except for some imaginary ones. Moreover, they agreed with the empiricists in regarding experiment as the umpire, albeit not an infallible one.

So, which is a truer account of science? Let us peek at only a few points of interest to philosophy: the genesis of hypotheses, the role of the prevailing worldview, the indicators involved in every measurement, the battery of indicators of factual truth, and Popper's puzzling view that falsification trumps corroboration.

2. Genesis of scientific hypotheses

Nearly everyone agrees that we should distinguish several kinds of scientific hypotheses: ordinary empirical generalizations, scientific empirical generalizations, low-level theoretical statement, high-level ones, philosophical principles, and wild speculations. In this chapter we shall confine ourselves to exemplifying these kinds and making brief comments on them. Here are some examples:

Ordinary empirical generalization: "All adult dogs can bark."
Scientific empirical generalization: Galileo's law of free fall.
Low-level theoretical statement: Huygens's pendulum law.
High-level theoretical statement: Newton's laws of motion.
Philosophical principle: All material things are changeable.
Wild speculation: There are ideas outside human brains, and some of them – surely mine – will outlast humankind because they are incorporated into books, disks, pictures, and other inmates of the *Geistwelt*, or World Three, that are likely to survive a nuclear holocaust.

Theoretical physics contains extremely general statements, such as the Newton-Euler laws. However, even these proved to be limited, and were eventually generalized for generalized coordinates, which can be

interpreted in non-mechanical terms, and are thus utilizable in electrodynamics and even in economic theory. The resulting equations are the Euler-Lagrange ones, which in turn are derivable from the variational principle about the system's lagrangian or action L, which states that the integral of L between any two instants is either a maximum or a minimum.

Hamilton's and similar variational principles are of particular philosophical interest for the following reasons. First, they are too far removed from measurements to be directly testable. Indeed, they are empirically *untestable*, yet at the same time the pinnacles of theoretical science, for they entail all the other general law statements. Incidentally, we keep the distinction, first drawn by the great physicist André-Marie Ampère (1834), between law or objective pattern, and the various law statements or formulas intended to conceptualize it.

Second, the earliest variational principle, namely the Maupertuis-Euler principle of least action (1744), seems to have been but the formalization of the metaphysico-theological principle that "nature is thrifty," as Maupertuis himself put it, or of the teleological assumption that every change is goal-directed, as Max Planck wrote. When William R. Hamilton rewrote it in 1834, the principle had lost all traces of its birth. The point is that some powerful scientific ideas are rooted in some of the rather obscure ideas born in some worldview or other.

Another, much more important, instance of the role of worldviews in the generation of scientific ideas and research projects, is the materialist principle that everything mental is cerebral. This ontological hypothesis, first stated by Alcmaeon (500-450 BCE), and adopted by Hippocrates and Galen, is no less than the spine of cognitive neuroscience, the contemporary phase of psychology.

An even more important case is that of Lucretius' principle of universal conservation: *Ex nihilo nihil fit* – nothing comes out of nothingness. Although Lucretius and the other ancient materialists were banned by all the theocracies since Justinian, that broad metaphysical principle resurfaced in the French Enlightenment of the 1700s.

Most historians of science seem to agree that Lucretius' materialist poem *On the nature of things* inspired the parents of the principle of conservation of energy, in particular the brewer James Prescott Joule (1843) and the medic Julius Robert Mayer (1845). This principle is not just one more hunch, but the first axiom of thermodynamics and a charter member of the modern *Weltanschauung*. One of its consequences, the impossibility of perpetual motion, is so important to technology, that the employees of patent offices spend much of their time examining the designs of the fake perpetual motion machines proposed by ingenious

inventors who share Popper's belief that, since energy conservation is hypothetical, it may eventually be confuted.

3. External consistency

Everyone, except for the Hegelians and the posmodernists, admits that internal consistency is a must for any theory. How about *external* consistency, or compatibility with the bulk of antecedent knowledge, or even with the main postulates of the prevailing worldview? Let us recall three famous cases in 20th century physics: those of beta decay, steady-state cosmology, and multiverse cosmology.

Careful radioactivity measurements performed in 1911 seemed to show that beta radioactivity violated energy conservation: the energy of the products of radioactive decay involving the emission of an electron seemed to be smaller than the energy of the input. In 1933, Enrico Fermi suggested that an unknown particle carried away the missing energy. Because the hypothetical particle lacked electric charge, he called it a *neutrino*. But the neutrino defied all detection attempts until 1956. In 2015 beta decays with two neutrinos were discovered, and at the time of this writing neutrinoless decays are being sought – in defiance of the assumption that all scientific progress involves simplification.

Because collisions involving neutrinos are rare due to their small energy, until very recently most neutrino detectors were gigantic. So far, the largest is the IceCube, an array that occupies one cubic kilometer situated near the South Pole, and started to work in 2004. So much for a useless particle invented with the sole goal of saving energy conservation – one of science's sacred cows.

Second example: in 1948 the cosmologists Hermann Bondi, Thomas Gold and Fred Hoyle, parents of the steady-state cosmological theory, attempted to save its "perfect cosmological principle" from the standard interpretation of observed red-shifts, namely the expansion of the universe – or, more exactly, the increase in inter-galactic distances, since the predicate "expansion" makes sense only for finite things, and, so far as we know, the universe may be spatially infinite. The theory attracted the attention of those who disliked the Big Bang hypothesis, which suggested that the universe had a beginning – anathema for the prevailing secular and materialist worldview, according to which the universe has always existed (Bunge 1955).

The cosmologists in question attempted to save their theory by adding to it the hypothesis that matter was gushing out of nothing at the rate needed to balance the decrease in overall mass density accompanying the

expansion. Of course, there is nothing wrong about ad-hocness as long as it is independently testable. But the said *ad hoc* conjecture contradicts all the conservation laws accepted in physics, starting with the conservation of energy (Bunge 1962). This exercise led me to add external consistency to the list of scientificity criteria (Bunge 2017). Since then, the continuous creation hypothesis has been quietly buried.

A third and last argument for the external consistency criterion is the battle over the mind, which has been going on for over three millennia. Though published in 1977, the Popper & Eccles volume *The Mind and its Brain* does not contain a single reference to papers in cognitive neuroscience. This was quite a feat, since the earliest victories of this discipline go back to Philippe Pinel, the founder of scientific psychiatry (1793), and Paul Broca's seminal paper of 1861 on the localization of speech production in the left cerebral cortex – Broca's area.

Philippe Pinel's philosophical idea that mental diseases are brain diseases, and consequently mental patients should be treated just as humanely as any other sick people, was put into practice nearly half a century before Broca's paper. Besides, Pinel's work inspired the 1838 French law, as well as the 1845 British Lunacy Act, enforcing the "moral" (humane) treatment of mental patients. In earlier times these had been chained, beaten, and sprayed with cold water. (This tradition remains in the name *loco*, Spanish for 'insane', given in Chile and Perú to certain prized marine molluscs that are softened by beating before being cooked.) So much for the view that philosophical materialism is immoral. Actually psychoneural dualism is immoral because it justifies torture and the death penalty, since the executioner cannot harm the immaterial and immortal soul.

In any event, the above-mentioned popular book by Popper and Eccles appeared more than a century too late, and only to support an unscientific view of the mind. Moral: Tell me which scientific advances your philosophy favor or hinder, and I will tell you its worth (see Bunge 2012).

Terminological excursus: the term 'materialism' calls for qualification, for it designates three very different ontological doctrines: (a) *physicalism* or vulgar materialism, according to which Material = Physical; (b) *dialectical*, according to which Material = Synthesis of opposites; (c) *systemic*, according to which *Material* = *Changeable* (Bunge, 1981, 2012.)

4. Indicators

An indicator, marker or sign of a property of a real thing is an observable, preferably a measurable one, of it. For example, the deviation

of a magnetic needle is an indicator of the presence of an electric current, and an abnormally high concentration of glucose in blood is a diabetes indicator. Indicators mediate between unobservables and observables:

$$\textit{Phenomenon} \rightarrow \textit{Dial reading} \rightarrow \textit{Knowledge of fact}$$

The main problem that astrobiologists are currently tackling is to identify which if any of the thousands of recently discovered exoplanets are homes to living beings. Given that those planets are trillions of kilometers away, that is a daunting task involving biosignatures, or life indicators, in otherwise unknown planetary atmospheres. Prima facie, water would be a good candidate, but it would be hard to find because sunlight can decompose water, thus freeing its hydrogen, which could easily escape into space. Therefore, only heavier gases would do as reliable biosignatures. Stay tuned.

Francis Bacon, usually presented as a crude empiricist, intuited that the oscillation period of a pendulum, or of a pendulum clock, depends on the gravitational pull, and that in turn the latter is weaker, the greater the height. To test this hypothesis, Bacon planned to compare the time shown by a pendulum clock raised to the highest church spire in town with that shown by a similar clock bound to the ground.

This experimental design was ingenious, but hard to implement with the coarse instruments available at the time. It was tried two centuries later, and its result confirmed Bacon's hunch: the gravitational pull decreases with the distance from the planet, a fact that settled the age-long controversy over whether weight is an intrinsic or a relational property of bodies.

Bacon's ingenious albeit failed experiment was only an episode in the centuries-long saga of indicators – also called signs, markers, or proxies. This story started with the search for reliable indicators of time intervals, mass, specific gravity, time, viscosity, acidity, and many other properties. We now have precision anemometers, chronometers, scales, galvanometers, spectrographs, pH meters, Geiger counters, and other physical and chemical contraptions, far more precise than the ancient sand-clock, aqua regia, and litmus paper. All science students become familiar with indicators in their lab practices.

Physiologists and psychologists too have invented a number of quantitative indicators. For example, Pavlov used the amount of saliva secreted by his dogs at the sight of a meat morsel as an indicator of their hunger. The pupil's contractions and dilations have been used routinely as hate and love indicators; and a commercially available eye tracker is

routinely used to find out the point of gaze, and thus the subject's movement intentions.

Archaeologists and anthropologists have been using indicators, such as tools, earthworks, and drawings, ever since our species was baptized *Homo faber* (working man). The alternatives *H. sapiens* (knowing), *adorans* (worshiping), *ludens* (playing), and *loquens* (speaking) have also been proposed, possibly under the influence of idealist philosophies. But all the indicators of craftmanship, learning, worship, play and speech are material: fossil bones and artifacts such as flint quarries, scrapers, harpoons, totem poles, fireplaces, and sheep nucklebones used as dice in games of chance.

Even believers in speech as what makes us unique should grant that the only evidence for this conjecture is what is also evidence for interaction and cooperation, such as remains of defense earthworks, communal buildings, whaling, and big-game hunting, that involve social organization, discussion, and planning, all of which in turn require something more sophisticated than grunting or gesturing. But the glossocentrists dismiss sociolinguistics: they focus on syntax, forgetting that sentences indicate or represent ideas or feelings, and that the main function of speech is communication. (See further discussion in Chapter 9.)

Since about 1960, a number of new social indicators have been devised for studying or managing formal social groups or entire societies. The best known of them is the UN human development indicator (1990), far more reliable than the GDP introduced in the 1930s. Since 1974 there has been a whole journal called *Social Indicators Research*. Yet, the very notion of an indicator or marker does not occur in the most popular philosophies of science, or even in theoretical physics textbooks.

Take, for instance, Dirac's *Principles of Quantum Mechanics* (1930), which in my student days was regarded as the bible of quantum mechanics, though it was seldom used for teaching because it reflects its author's proverbial laconism. This work postulates that the eigenvalues of "observables" (dynamical variables) are the values their measurement may yield. This assertion comes from the operationist philosophy tacitly accepted uncritically by the faithful of the Copenhagen school, but is at variance with experimental physics.

Consider, for instance, the Hamiltonian or energy operator H of a quantum-mechanical object such as an atom. H and the state function Ψ occur jointly in the basic formula (axiom) of quantum mechanics, namely $ih\partial\Psi/\partial t = H\Psi$, where i is the imaginary unit and h the Planck constant divided by 2π. Of the three variables, only t, interpreted as time, is

measurable – though of course not directly but through some indicator such as the angle swept by the needle of a chronometer.

As for the eigenvalues E_i of H, they are not measurable either; only the difference between the two energy levels E_i and E_j is measurable, for it equals the energy of the radiation emitted or absorbed during the $i \rightarrow j$ quantum jump. But this measurement too is indirect: one uses a comparator to measure the corresponding wavelengths. As for the state function Ψ, every eigenvalue measurement is also a test of the corresponding Ψ, one of the most elusive physical magnitudes.

How does the external consistency criterion work in microphysics? It works through what Niels Bohr called the *correspondence principle*. According to it, the quantum-theoretical results must approach the corresponding classical formulas for large quantum numbers. The problem with this condition is that most quantum-theoretical formulas have no classical counterparts. Indeed, recall that the quantum theory was invented because classical physics did not even allow for the existence of atoms.

This hitch may be overcome by rewording the said principle, stating that the quantum-theoretical formulas must not contradict the classical ones – should they exist. This would apply to such macrophysical objects as blackbody objects (e.g., ovens), liquid bodies at "normal" temperatures, and even grandmothers.

Bohr had stated, tongue in cheek, that you could write a quantum-theoretical Hamiltonian for your grandmother (no mean feat!) by first writing her classical Hamiltonian, and then replacing every classical dynamical variable in it with its quantum-mechanical counterpart. However, some classical variables, such as vorticity and viscosity, have no quantum partners, and some quantum variables, like spin, parity, and chirality, lack faithful classical partners.

So, let us grant that the said problem persists and that, given its importance, it warrants devoting it some research projects. Incidentally, this is one of the functions for a philosophy in touch with the science of its time: to detect holes in the body of extant scientific knowledge. Regretably, the converse is usually found, namely big philosophical holes, such as a social philosophy capable of helping economists move forward instead of assuring them that they have been on the right track since about 1870, while in fact most of them have been incapable of explaining, much less predicting, any economic crises of their time.

5. What about induction?

Where do the previous considerations leave induction, a component of the standard empiricist view of scientific research? The short answer is that induction is still being used in the so-called soft sciences, like anthropology, but is nearly useless in the hard sciences. Induction has a limited use even in biomedical research, where receptors, genetic editing and immunity factors must be imagined because they do not occur among the empirical data, or rather *peta* (or sought), as I prefer to call them, since they are not given (Bunge 2017).

I have just suggested that induction has a role to play in finding and testing low-level scientific generalizations, such as Ohm's law and the fever-inflammation connection. But to understand and perfect such inductions we need higher-level generalizations, that is, law statements that do not contain some of the predicates occurring in the descriptions of empirical data or peta. For example, we explain Ohm's law, along with the other laws concerning electric and electronic circuits, in terms of electrons dragged by an electric field, and bent by a magnetic one.

Let us take a quick look at the equations for the electromagnetic field, that James Clerk Maxwell guessed around 1860. The primitive (undefined) concepts of his theory are those of electric current density and electric and magnetic field intensities. They occur in Mawell's six differential equations for the field, and one for the conservation of electric charge. None of these basic magnitudes are directly measurable. In particular, we measure the force $F = eE$ that an electric field of intensity E exerts on an electric charge e. The force exerted by a magnetic field on a charge is $e(v \times B)$, where v represents the velocity of the particle divided by the speed of light in a vacuum, and B for the magnetic induction. None of these magnitudes is directly measurable. The indirect measurement of each of these magnitudes calls for its own experimental device. For example, Robert Millikan measured the electron's charge as recently as 1909. And we get E by dividing F by e.

Maxwell's equations are potent and beautiful but mathematically hard to handle. To solve special cases one transforms them into second-order equations for the potentials ϕ and A defined tacitly by $E = -\nabla\phi - (1/c)\partial A/\partial t$, $B = \nabla\times A$. The resulting equations are $\nabla^2 A_\mu - (1/c^2)\partial^2 A_\mu = (4\pi/c)j_\mu$, where μ varies between 0 and 3. These four equations are testable only if enriched with the four formulas for the components of the four-density current j_μ, or field source. The reader may wish to draw the corresponding deductive tree, starting with the preceding equations, then conjoining them

with formulas for a specific current density, conjoining these with indicators, and ending up with the testable consequences.

The theory of antennas, which belongs in the intersection of science with communications engineering, is centered on the above formulas. Warning: although the formulas look straightforward, they are part of the solution to a problem that can be made as hard as desired. Indeed, the electrical engineer's task is to figure out the form of the current density corresponding to the desired shape, intensity and direction of the electromagnetic waves represented by a solution of those field equations. In short, the engineer is asked to solve a problem of the form: Given the desired output, find (reverse-engineer) the required input. For example, given the desired magnetic induction B, invent the potential A such that $B = \nabla \times A$.

Tip: that inverse problem has no general solution, so that one must resort to trial and error for every particular field configuration. Regrettably, the very notion of an inverse problem is alien to the vast majority of philosophers. It does not even occur in the standard philosophical dictionaries (see Bunge 2003, 2006).

Finally, because of the operationalist confusion between testability and meaning, sanctified by Rudolf Carnap in his famous if pathetic 1933 paper with the same title, it is usually said that the electrodynamic potentials are just mathematical auxiliaries devoid of physical meanings. But the equations they obey are equivalent to Maxwell's, which are central to classical electrodynamics. In other words, the electromagnetic potentials have the same referent as the field intensities they generate, namely the electromagnetic field.

Besides, A occurs in the so-called kinetic momentum $\pi = p - (e/c)A$ of a particle with charge e in an electromagnetic field A. That is, such a particle is accelerated when immersed in a field A. This happens even when B vanishes while A does not. In other words, the presence of A has a measurable effect even when its curl is zero. This fact, puzzling at first sight, is called the Aharonov-Bohm effect (see Bunge 2014a).

6. Popper's sophistry

Karl Popper (1955) rightly criticized inductivism, that is, the idea that scientists ascend from data to hypotheses – for instance, from microscopic observations to the hypotheses that the cell is the unit of life, and that cancer starts as gene mutation. And he added that, contrary to confirmation, refutation is conclusive. Let us briefly analyze Popper's argument.

The main pattern of deductive logic is the *modus ponens*: From $A \Rightarrow B$ and A, conclude B. Its negative counterpart, the *modus tollens*, reads thus: From $A \Rightarrow B$ and not-B, infer not-A. Popper thought that confirmation is cheap, whereas falsification is precious because it attempts to dislodge a strongly held myth. While Popper was right in stressing the great importance of hypotheses going beyond data, his logic was flawed.

Indeed, falsifying H amounts to confirming *not-H*, as I pointed out (Bunge 1959) as soon as the English version of Popper's *Logic of Scientific Discovery* appeared. Besides, the modus tollens is equivalent to the modus ponens. Indeed, $A \Rightarrow B$ is equivalent to not-B $\Rightarrow$ not-A, so that the assertion of both this conditional and not-B entails not-A.

Falsification is often a byproduct of a corroboration attempt. For instance, one proves that the square root of 2 does not equal the ratio of two integers by assuming that it is, and reaching a contradiction. Columbus stumbled across America by navigating westwards in his attempt to reach China. And Enrico Fermi postulated the existence of the neutrino in his effort to save the energy conservation principle.

I submit that Popper's attempted devaluation of confirmation is misguided and misleading because it ignores that the *modus ponens* is no less than the logical backbone of the experimental method. Indeed, when putting a hypothesis $A \Rightarrow B$ to an experimental test, one implements A and watches whether or not B follows. If A is materialized and B is found to occur, one concludes that $A \Rightarrow B$ is indeed the case. And if A is implemented but B fails to occur, we conclude that the hypothesis $A \Rightarrow B$ has been falsified. For example, if a biomedical investigator suspects that bacterium A causes disease B, she may inject a dose of A's into a laboratory animal and watch for indicators of B. If the latter do appear, she rightly infers that, as suspected, A causes B, whereas if B fails to occur, she rejects the hypothesis in question. Incidentally, inferring A from B and $A \Rightarrow B$ is to perpetrate the fallacy known as affirming the consequent – despite which it is often said to summarize the scientific method.

In short, experimentalists use, albeit tacitly in most cases, both the *modus ponens* or confirmation, and the *modus tollens* or falsification. In other words, both laboratory and field workers look for evidence, which may be positive, negative or inconclusive. In all three cases one hopes that the observation or experiment will be replicated as often as needed. And the lack of evidence is just as damaging as irrefutability, whereas compatibility with the bulk of antecedent knowledge is just as valuable as the finding of new positive evidence.

In addition, empirical evidence may be direct or indirect. For example, the Biblical stories of Christ's virgin birth and his resurrection after

crucifixion are implausible according to biology. The same holds for the story about the wandering of hundreds of persons in the inhospitble Sinai desert during 40 years. This indirect evidence, namely the impossibility of life without water and food, is reinforced by the utter absence of archaeological evidence such as fire pits, utensils and graves in that barren desert (Mazar 1990).

In short, Popper's falsifiability is no better than the inductivism it sought to replace. Moreover, neither of them accounts for trial and error, the strategy of tackling inverse problems like "Given B, invent A and try either $A \Rightarrow B$ or its converse" (see Bunge 2006). Most philosophers have regarded this "method" as being beneath both the hypothetico-deductive and inductive ones. Yet trial and error are central to science and technology, where the most interesting and hardest problems are inverse. See Figure 2.1.

Given *Sought*

(a) *Direct* /\

Input → vvvvvv → Output → Test → Conclusion

Given *Assumed*

Input

(b) *Inverse* Output → < > → Test → Conclusion

vvvvvv

Fig. 2.1 Direct and inverse problems. The serrated line symbolizes the mechanism converting inputs (causes or premises) into outputs (effects or consequences). Mechanisms are material things or processes in the case of causation, and logical laws in that of reasoning.

Think of medical diagnosis – the guessing of causes from syndromes – or of engineering design —drawing the blueprint of the machinery that is hoped to deliver the desired product. Simpler yet: think of sleuthing, where the detective starts with indicators of a presumed act of crime. Or think of the historian's attempt to reconstruct the past from the present – a task that requires inventing plausible pasts as well as plausible past-present trajectories. A more sophisticated example is the proof of a mathematical theorem by seeking the premises entailing it. A far less familiar example is the axiomatization of a theory starting from a few well-known theorems. In all of the above cases one works against the deductive stream. And one's trials, far from being blind or random like those of a child playing with her first chemistry set, are guided by educated guesses.

Since guessing is not mechanizable, it is safe to bet that no algorithms for solving inverse problems will ever be invented. Similar reasonings lead us to devaluing the computational models of the human mind. Humans had to make do with lowly trials long before inventing effective "mechanical" rules for solving direct problems. Even nowadays, in the midst of the information revolution, we admire and reward the lucky guess that solves a deep inverse problem far more than the patient computation that solves a complex but shallow direct problem.

Conclusion

The standard philosophies of science are hardly of interest to the practicing scientist or technologist because they do not detect, let alone analyze, most of the philosophical problems raised by scientific or technological research. In particular, logical positivism failed because it kept phenomenalism and focused on low-level generalizations. And logical negativism – that is, Gaston Bachelard's *philosophie du non* and Karl Popper's falsifiabilism – ignores that Nobel prizes reward discoveries or inventions, not confutations of myths.

More importantly, none of the popular philosophies of science has inspired any cognitive breakthroughs, partly because none of them contains an explicit ontology or metaphysics, and so none of them intersects with the worldview that has inspired scientists and technologists since the Scientific Revolution. The good news is that, if we discover a hole in our epistemic network, we may do something to mend it, such as hanging a realistic epistemology from a materialist and systemic ontological hook. This will be the subject of the next chapter.

3. Interdependence of Epistemology and Metaphysics

Aristotle was the earliest total philosopher, that is, the first to work on all the branches of philosophy we distinguish nowadays. This broad conception of the task of philosophers was considerably narrowed when physicists, from Galileo on, replaced metaphysicians in the task of accounting for nature. Since then philosophers have confined their attention to epistemology, or the theory of knowledge and ignorance. Even chance and justice have been regarded as events behind the veil of ignorance.

Descartes and Leibniz kept doing speculative natural philosophy, but the physicists ignored them, and the Cartesian vortices, along with the Leibnizian monads, became eventually objects of derision, although the rest of their work has continued to be admired to this day.

The Accademia Nazionale dei Lincei, founded in 1603, included the humanities along with the natural sciences, but not metaphysics, which was reviled by the scientists as well as by the philosophers, nearly all of whom were far more interested in certain knowledge and the right conduct than in the general problems of being and becoming. Almost everywhere philosophers followed either Locke or Kant, the two sources of positivism. The only exceptions were Bernard Bolzano, Rudolf Hermann Lotze, Charles S. Peirce, and the Thomists. But only mathematicians knew of Bolzano; Lotze was interesting but too long-winded and out of tune with the materialism practiced by most scientists; Peirce's metaphysical fragments were only programmatic and under the shroud of Duns Scotus' scholasticism; and the Thomistic philosophy of nature was cultivated only by Catholics indifferent to the new sciences.

True, the Romantic philosophers of nature, particularly Hegel, Fichte and Schelling, rescued metaphysics, but found followers only in Germany. Ironically, the most influential of their followers was Friedrich Engels, the founder of dialectical materialism, the philosophical branch of Marxism. But *au fond* he was a philosopher of nature, since he did not hesitate to criticize in a Hegelian vein a number of physicists, particularly Newton, whom he did not understand for ignorance of the requisite mathematics. In the succeeding century the Russian Marxists, with the exception of Georgy Plekhanov, followed Engels and opposed all the scientific novelties of

their time, from formal logic to the two relativities, quantum physics, evolutionary biology, cognitive neuroscience, and empirical sociology, for not being dialectical, in particular for not assuming that every existent is a unity of opposites, and that all change comes from "contradiction."

In short, metaphysics was marginalized between roughly 1600 and the end of World War I. Heidegger's attempt to resurrect it just confirmed the antimetaphysical bias; Wittgenstein's mature philosophy only attracted philosophers more interested in words than in things; and Peter Strawson (1959) only succeeded in unearthing the archaic metaphysics of the common Oxfordshire residents.

Still everyone, in and out of the philosophical community, kept asking hard metaphysical questions, such as "Which are the building blocks of the universe?," "How are brain and mind related?," and "Is society anything other than a collection of individuals?" Such questions can be pushed aside for a while, but they keep recurring. In fact, eventually the first of them was addressed by atomic physicists, the second by cognitive neuroscientists, the third by sociologists, and all three by philosophers more interested in problems than in either authors or words.

In short, metaphysics can be silenced for a while but not suppressed forever, because being and becoming come before thinking about them. Indeed, knowledge is a recent arrival in the history of the universe: it came with the earliest animals with brains capable of learning something about themselves and their surrounds. Correspondingly, historically ontology preceded epistemology. These facts suffice to confute Berkeley's principle "To be is to perceive or to be perceived," as well as Kant 's dictum that the world is the sum total of phenomena (appearances). As for nonexistents, we cannot know them unless they are products of our imagination. Thus, when saying that someone knows a certain piece of mathematics or fantastic literature, what we mean is that it has been invented, or that we pretend that it exists. That is, all knowledge is either of real existents or of ideal objects such as numbers and abstract structures (Bunge 2017).

1. The scientific outlook

A worldview is a broad conception of all there is and all there ought to be. Presumably all animals, or at least all mammals and birds, learn something from their interaction with their immediate surroundings – for instance, that it contains edibles as well as inedibles and eaters. But, so far as we know, only humans have crafted coherent conceptual systems of "core beliefs" about the universe and some of its constituents, in particular themselves. Presumably, they have done so at least since they emigrated

from their ancestral homes in West and South Africa about 200,000 years ago. Of course, we may never discover what those beliefs were. But we can be sure that, at all times, some people saw the big picture in addition to noticing details of their immediate surrounds. Otherwise they would not have undertaken long voyages or the execution of lasting works.

It is also likely that our remote ancestors changed the way they saw their immediate and faraway surroundings as they invented new tools. For example, it may well be that the hominims who sought shelter in caves saw their external worlds as more hospitable than those who climbed trees to escape their predators. But we can only guess what the members of preliterate societies thought, for their "footprints" can be interpreted in many different ways. Just think of the various speculations on the different meanings of the cave paintings: didactic props, offerings to supernaturals, or artworks?

There have been a number of quite different worldviews: religious and secular, magical and pragmatic, optimistic and pessimistic, nihilistic and Manichean, deep and shallow, coarse and refined, theocentric, anthropocentric, and acentric, Buddhist and Pythagorean, tribal and universal, dogmatic and open, spiritualist and materialist, and so on.

Some philosophical systems, such as Epicureanism, Stoicism, Aristotelianism, Cartesianism, Hegelianism, vulgar materialism and Marxism, have been so broad, that they have worked as worldviews – alas, of the dogmatic kind. The attraction of dogmatic worldviews is that they provide rough and ready answers to all deep questions, so they snuff out dubt and render laborious research unnecessary: they claim to accomplish what the "theories of everything" only promise.

The scientific worldview is only one of many worldviews – in fact, one of the youngest, since Galileo (1564-1642) may have been its earliest consistent practitioner. This worldview is characterized by its rationality, acentricity, secularity, realism, materialism, proximity to current science, coherence, openness to epistemic novelty, and willingness to both examine counterintuitive ideas, such as those of massless particles and thinking matter, as well as to check them.

Let us comment briefly on two of the features of the scientific worldview: its rationality and realism. Neither of these comes naturally, as the frequency of logical fallacies and the reluctance to accept adverse facts suggests. Recent psychological experiments (Mercier & Sperber 2017) suggest that, once we have "made up our mind" about something, adverse facts are unlikely to change it: we tend to protect our most cherished beliefs. This is called the *confirmation bias*.

The unscientific approaches are typically unrealistic. Thus, when people started asking President George W. Bush for evidence in support of his claim that Iraq had to be attacked because it had nuclear weapons, one of his courtiers claimed that the President did not need it because he acted on his gut feelings, and his party created reality instead of adapting to it, the way the "reality-based community" did (Stone and Kuznick 2012: 532).

A better known case of blind faith is the persistence of orthodox economics, which has not changed appreciably since its birth around 1870 despite its inability to explain, much less predict, any of the major economic upheavals that happened since its birth, such as the incapacity of markets to correct themselves without governmental regulations and bailouts, both of which are anathema to the free-market dogma. Much the same holds for all the other rational choice theories, from political science to ethics: they all assume that humans are so free and selfish, that they always act so as to maximize their expected utilities. The believers in this postulate ignore that it has been confuted by experimental psychology (see, e.g., Bowles & Gintis 2011).

Another scandalous case of reluctance to alter one's core beliefs in the face of adverse evidence is the resilience of the main political ideologies despite catastrophes such as their electoral routings and their inability, when in power, to tackle basic social issues without ruining the lives of millions of people – as in the cases of chronic unemployment, the unraveling of the European Union, and the negative reactions to "humanitarian interventions" in other countries' internal affairs, aka imperialism. Few professional politicians will risk "losing face" by admitting having made costly mistakes for having failed to adopt a scientific stance in facing facts, theories, or their relation. They behave like Hegel when told that his philosophy of nature did not fit the world: he is said to have answered "So much the worse for facts."

To evaluate the merits of the scientific worldview we shall briefly examine two controversial topics: the nature of the mind and of space – two objects notorious for their alleged immateriality. The atomists, from Democritus and Epicurus onwards, regarded the mind or soul as material, whereas Plato defended the spiritualist view of the mind as immaterial and self-moving. Although Aristotle could not benefit much from the emerging science of his time, he made two important contributions to their study: he regarded space as a physical object, and mind as "the form of the human body," hence both as so many objects of what was to become scientific research.

Descartes took it for granted that all things exist in space and time, and added that therefore they should be described in purely spatio-temporal

terms – which constituted a tacit rejection of the occult powers posited by the schoolmen. Leibniz characterized space as "the order of coexistents," and time as "the order of successives." Newton wrote that space and time constitute the Deity's sensorium, and as such they exist absolutely, i.e., regardless of anything else. But in his physics Newton took it for granted that they are physical items that exist by themselves, so that they would subsist even if all the material things were to vanish. By contrast, Berkeley regarded space and time, along with all material things, as subjective. Following him, Kant shifted space and time from the physical world to the knowing subject's intuition. Had scientists followed Kant, science would have been swallowed by one of the most backward worldviews in history, namely phenomenalism – a version of anthropocentrism.

In Einstein's special relativity space and time are fused, and in his theory of gravitation they combine with matter. In fact, the central equation of this theory is "The metric tensor is proportional to the matter tensor." A consequence of this equation is the gravitational waves equation. These waves were first detected in 2015, one century after being conjectured. Since these waves consist in ripples in spacetime, their existence suggests that the latter is material, as all and only material things are changeable. We will return to this in chapter 11.

The said experimental finding should be interpreted as the rejection of the last remaining immaterial constituent of physics, and thus an unexpected triumph of materialism along with an invitation to broaden the experimental study of physical spacetime, such as the measurement of large physical triangles formed by intersecting light beams.

The materialism in question is not to be equated with physicalism, or the postulate that there are only physical entities. Indeed, the set of material things includes some that, though ultimately composed of physical things such as atoms, are endowed with nonphysical properties, such as being alive and behaving in a solidary manner. Such supraphysical properties are said to be *emergent*, and the corresponding version of materialism may be called *emergent materialism* (Blitz 1992, Bunge 2003).

Moreover, since emergent properties are characteristic of systems of lower order entities, such as ice cubes, organisms, and schools, emergent materialism is the same as *systemic materialism*, which overcomes both physicalism and dialectical materialism (Bunge 2003).

Let us next spy on the soul concept inherent in both spiritualism and psychoneural dualism. If the soul or mind is regarded as immaterial, it must be studied separately from neuroscience. But since the mid-nineteenth century, when the Broca and Wernicke areas were discovered, and a century later Hebb's cell assemblies were invented, brainless

psychology has been gradually replaced by cognitive and affective neuroscience. The root of this discipline is the materialist conjecture of Alcmaeon and a few others, that everything mental is cerebral.

The epistemological counterpart of this ontological doctrine is the principle that neuroscience is the clue to the understanding and repair of mental processes such as memory, perception, imagination, reasoning, emotion, delusion, and mental diseases such as depression. Thus, the materialist worldview has replaced Lewis Carroll's faceless grin of the Cheshire cat – a brilliant piece of literary fiction.

In other words, in the light of science, grins are nothing but contractions of face muscles, so we should study them as specific functions of the simian face. However, we may occasionally feign that there are faceless grins expressing amusement, doubt or pain, just as we may study working memory without locating it in the brain. Likewise right-wing ideologists may pretend that "the market knows best" (Friedrich Hayek), as though markets had brains, and as if democracy were "market-based" (Barack Obama). But realists know that genuine democracy is people-based, or both inclusive and participative (Abraham Lincoln).

It is generally admitted that, whereas metaphysics studies being and becoming, epistemology explores ways to advance metaphysics. Indeed, if we wish to study X, we must start by knowing or assuming at least the kind of thing X is: real or imaginary, natural or artificial, biological or social, and so on. For instance, if we share Aristotle's thesis that space and time are physical traits, we shall conduct physical investigations of them, whereas if we adopt the view of Berkeley and Kant, that they are mental, we shall resort either to introspection or to the psychology of space and time perception – which, as the Lyell and other illusions showed, is quite unreliable.

In other words, far from being divorced from metaphysics, epistemology presupposes some of it. But, of course, the study of space and time is hoped to refine our previous metaphysical intuitions of them. In turn, familiarity with such refinements may lead to richer intuitions. Thus, what is impenetrable to the beginner may be obvious to her teacher.

In other words, the hope is that, for any topic X, curious people start with a preliminary Metaphysics_1 of X, and go on to learn a preliminary Epistemology_1 of X, which in turn allow them to learn or craft a more advanced Metaphysics_2 of X, and so on. Failure to admit this historical alternation of metaphysics and epistemology has resulted in fanciful metaphysical speculations, such as Schopenhauer's radical voluntarism, as

well as in extravagant epistemologies, such as Popper's falsificationism and David Lewis's possible worlds metaphysics.

4. HUMAN NATURE IS UNNATURAL

Naturalism is the worldview according to which all existents are natural – or, in short, it postulates that Universe = Nature. In antiquity, this conception was common to Epicureans and Stoics. In the Middle Ages, naturalism was revived by the Averroists and other members of the materialist wing of Aristotelianism. In the early days of modernity, naturalism was rejuvenated by Descartes in his two treatises that he did not dare publish, but was embraced by Hobbes and Spinoza, as well as by the radical wing of the Enlightenment – that of Holbach and Diderot. Naturalism, or vulgar materialism, became popular among natural scientists around 1850, and shortly thereafter it became even more popular among the Darwinists.

Nowadays naturalism is all the rage among the proponents of pop genetics and pop evolutionay psychology, who believe they have invented it. Indeed, naturalism is inherent in the popular maxim *Biology is destiny* (Barkow et al. 1992). In the following it will be argued that there would have been nothing wrong with this thesis had it been introduced before the first hominims gathered in bands to create things and processes, such as huts, arrowheads, satchels, and sandals, which were not to be found in the wild.

1. How natural is human nature?

Although the official name of our species is *Homo sapiens sapiens*, some people have preferred *rational animal*, *homo faber, coquerens [cook], loquens, adorans*, *bellator [warrior]*, *ludens [player], ethicus, cooperans,* or *crudelis*. Still others opt for the *self-domesticated, problematizing, soul-owning, political animal, God's imitation* – or have even proclaimed, as the televangelist Billy Graham did, that, "we are fallen creatures living in a fallen world."

That famous man of God did not mention the cooperatives of destitutes, such as abandoned children, who organize themselves into self-managed cooperatives to eke out their livelihoods in shantytowns. While there are plenty of feral cats, there have been only two well-documented feral children: Kaspar Hauser and Victor de Aveyron, both in the early 19th century.

When abandoned or fugitive, children tend to band together, help each other, and survive by scavenging and collecting, sorting and selling garbage, as thousands of children have been doing around México City and Río de Janeiro. They are marginal but refuse to be totally excluded from society. They are certainly downtrodden, but not fallen in the theological sense, for they sift through garbage mounds, and survive through hard work and solidarity.

No doubt, every normal human being is a *social animal* – the title of a standard textbook in social psychology (Aronson 2011). But there are dozens of species of social organisms, among them clumping bacteria, coral colonies, honeybees, meerkats, and gorillas. Perhaps *the self-domesticated* animal and *the living artifact* are better names, as they encompass some of the previously listed nicknames. In addition, they suggest that all the disciplines that study us are *biosociological* rather than biological (naturalism), spiritual (idealism), moral (Hume), or human – as if the other sciences were unhuman.

The qualifier *biosociological* invites us to fuse all the disciplines dealing with people, from zoology, neuroscience, demography and epidemiology to anthropology, sociology, and historiography. The same qualifier warns us not to circumvent the social, by jumping from the individual brain to economic transactions, as if these were individual processes like digesting and navel gazing. And the qualifier *social* in "cognitive and affective neuroscience" focuses on the neural aspect of social behavior, from love and play to trade and war. The same qualifier in "biosocial evolution" reminds us that, because humans domesticate themselves, human evolution has been artifactual as well as natural from the moment the first tool and the earliest social norm were crafted (Trigger 1998, Richerson & Boyd 2005).

The naturalist dogma that humans are just smart talking animals may have been true for the Holocene period, but it does not hold for its successor, the Anthropocene. This period may have started some 15,000 years ago with the birth of agriculture, which included cooking as well as the burning of forests for the cultivation of open land and the dispersal of plant species. Pristine nature was then replaced with the man-made nature we know and keep wasting.

Feeling love or hatred is personal, but marriage and revenge are just as social as trade. Likewise, whereas killing is biological, murder is social. And whereas keeping warm is animal, dressing *à la mode* is a social status symbol. Actually, all human behavior except scratching one's head is social to some extent, because it happens in a social context, affects others, and leaves traces on the environment as well as on the actor's brain. What

holds for ostensive behavior also holds for inner life, not only cognition but also emotion: remember the social emotions, such as love and hatred, guilt and remorse, pride and shame, admiration and contempt. See Table 4.1.

Table 4.1 Natural vs. artificial items

Natural	***Artificial***
Advising	Ordering
Assistance	Servitude
Barter	Commercial transaction
Blueprint	Building
Carrion	Roast
Cave	House
Community	Town
Custom	Institution
Darkness	Artificial light
Dinohippus	Horse
Gang	Formal organization
Grunt	Word
Homo erectus	Homo sapiens
Naked body	Clothed body
Nap pause	9 to 5 work schedule
Hunting	Animal domestication
Leader	Chief
Learning	Schooling
Love	Marriage
Medicinal herb	Drug
Naked	Clothed
Napper	Nine-to-fiver
Plot	Garden
Plant gathering	Plant cultivation
Raw	Cooked
Sex	Birth control
Sharing	Taxation
Snap decision	Researched decision
Spontaneous	Planned
Tree branch	Club
Teosinte	Corn
Use	Ownership
Walking	Riding
Wild	Domesticated
Wolf	Dog
Worth	Price

That sociality greatly contributes to "defining" us and other animals, is obvious from the way that social exclusion damages us, and the revulsion that sociopathy elicits in most people. Thus, autism is a serious disease, solitary confinement a very harsh punishment and even a kind of torture, and deafness is an even more painful inability than blindness or muteness because it isolates individuals. Moreover, social interactions reach the molecular level, for the release of oxytocin in the ventral tegmental area – which sits on the brainstem – is necessary to elicit social reward (Hung et al. 2017). Thus, sociality involves the whole *scala naturae*, from molecule to society (for levels of being see Lovejoy 1936, Bunge 2003).

Recent research in social psychology has shown that loneliness shortens the lifespan (Cacioppo et al. 2002). Nor is the deprivation of social contact damaging just to people. Puppies reared in cages develop into abnormal adults; and hungry capuchin monkeys prefer the company of conspecifics to food. Pleasure too can be vicarious, as in charitable donation and voyeurism.

In short, humans are social animals. Hence they can experience *social pain* in addition to physical pain. The distress component of pain in either form seems to be a function of the dorsal region of the anterior cingulate cortex, the bridge between the sensory systems and the insula (Lieberman and Eisenberger 2009).

For humans, sociality is much more than gregariousness: being social involves crafting or maintaining social systems or "circles" of various kinds. And human social systems are more than shoals, flocks, herds, or other groups of conspecifics: they involve inventing, observing or altering norms of behavior and institutions such as mutual aid, teamwork, schooling, defense, play, and more. Such institutions emerged and evolved for defense, conflict resolution, production, and trade. We struggle for survival, but cooperate for coexistence, and in the process we craft and revise behaviors that are not encoded in our genomes (Smail, 2008, Bowles & Gintis 2011).

That such social norms are made and eventually reformed or discarded, rather than engraved in our genomes, is suggested by the fact that some of them harm us instead of helping us live. Just think of the dietary "laws," the sale of daughters to pay off debts, honor killing, slavery, genocide, aggressive nationalism, and imperialism. All those are both artificial and harmful.

When social institutions fail, as they do in the cases of unprovoked aggression and the stealing of land or people, the aggressors are often said to behave "savagely." But the idea that all primitives are violent has been just as discredited as the myth of the good savage. Competitiveness,

supposedly an inborn masculine trait, depends on the kind of society: in matrilineal societies it is more pronounced in females than in males (Gneezy, Leonard & List 2009). Likewise, kindness and wickedness are learned, not inborn. At birth we are neither good nor bad. But we are born with the capacity to become either good or bad persons.

The bewildering variety of social norms across societies and over time shows that "most human behavior is not under direct genetic control" (Harris 1979: 136). I got my first human nature at birth, but am still working on my second nature. In particular, I was born with what Herder called *appetitus noscendi*, but it took me a long schooling and many trials to learn how to do scientific research on my own. As I learned, my plastic brain got partially rewired. Presumably, only our basic behaviors, such as breathing and swallowing, are hardwired or innate. What makes us human is not our original nature but the neural plasticity that accompanies the acquisition and loss of behaviors, tastes, habits and beliefs – that is, the second natures that nativists or innatists miss because they are not interested in our ever changing brains (see e.g. Kolb & Gibb 2014).

Nativism is not a result of scientific research but an ideology often used to excuse slavery, racism, mysogyny, and even school-tax evasion. In short, Plato's born mathematician, Aristotle's born slave, Lombroso's born criminal, Chomsky's born linguist, Pinker's born aggressor, and Gopnik's scientist in-the-crib are so many fantasies, as well as excuses for not investigating how potentialities develop into actualities – or fail to do so.

For instance, we have only recently learned that, unlike all the other animals, humans have no reproductive instinct: that we have to learn, by imitation and by trial and error, how to make babies (Wunsch & Brenot 2004). In other words, full-blown sexuality, which is instinctive or natural in most other animals, is partly learned in humans. This is why in preindustrial societies knowledge about the reproduction mechanism has been shrouded in myth. In short, human nature only flourishes in society – provided the ruling ideology allows it. The philosopher Kwame Appiah (028: 125) put it pithily: "For us human beings, there is no clear dividing line between nature and culture." For example, nature made us like food, but we taught ourselves how to gather, grow and cook it.

As Marx wrote, we make society, and society makes us – though, *pace* Marx, society does not feel or think "through us," because it is brainless. Hence, although we must distinguish individuals from their social niches, we should not detach them, if only because even lowly organisms like earthworms build their own niches, though not always adaptively.

Adverse social circumstances may sicken us in various ways. For example, loneliness and forced social exclusion due to discrimination,

arbitrary subordination, economic insecurity, unemployment, or restricted access to public health facilities may cause anxiety, stress, depression, social phobia, eating disorders, and even heart disease and self-harm (see Marmot *et al.*1978).

Socioeconomic status is thus a key etiological variable. And, as an interdisciplinary and international team of a dozen researchers has recently found, among macaques – which are close evolutionary relatives of ours – "social subordination alone is sufficient to alter immune function even in the absence of variation in resource access, health care, or health risk behaviors" (Snyder-Mackler et al. 2016: 1041). In short, the lower the social status, the greater the likelihood of falling sick. The political moral is obvious: equal opportunity is medically desirable.

No wonder that emigration can be deeply unsettling, and that many of the patients of clinical psychologists suffer from the "broken heart syndrome" following widowhood. Transplantation harms people no less than trees. Just think of the refugees from persecution, ethnic cleansing, and war. They suffer not just from biological deprivations but also from abandoning their habitual social "circles" or systems. Much the same is also true of the unemployed, who lose not only their lifestyles and self-respect, but also their reassuring contacts with their erstwhile peers. After all, sociality is hewn into our brains, as suggested by the finding that the macaque monkey's brain includes a network that is exclusively engaged in social interaction analysis (Sliwa & Freiwald 2017).

Cuts in social services, particularly in public health, have similar effects. For example, the longevity of Britons decreased significantly under the so-called neoliberal rule of Margaret Thatcher (Wilkinson & Pickett 2010). The austerity policies currently practiced in many European nations are having similar consequences. A visible effect of the cuts in public health care is the higher rate of toothless people in the poorer neighborhoods of any town, as tooth extraction is far cheaper than cavity filling. Thus toothlessness is a poverty indicator.

The neuroscientist's job is to discover the neural systems and processes involved in feeling, planning, or controlling social processes, that is, strings of events that affect others. For instance, a psychologist may wish to discover whether a particular action is free (spontaneous) or compelled by an external stimulus, as well as the brain subsystems activated or inhibited during that action (Hebb 1949). The result of such study may be used to design and implement behavior norms and institutions aiming at either encouraging or discouraging actions of that kind. In general, we ought to learn before doing.

We do not learn by withdrawing from society but by mixing with others, imitating some of them, debating in families, schools, gangs, workplaces, and other social systems, both formal and informal. Studying and inventing are individual, but education and innovation are social.

Moreover, social learning depends on group size. Indeed, learning simple tasks can be achieved by imitating an expert, but the invention and transmission of complex tasks requires social groups that have attained a critical mass, as well as a leadership imbued with the ability and courage to shed barren traditions and embracing and nurturing advancements of various kinds, from new uses of known tools to more efficient or more just social regimes. The presence of such conditions favors cultural renewal and accumulation, whereas their absence leads to stagnation, decadence, or even collapse (Henrich 2016).

The most popular topics in recent social cognitive and affective neuroscience are social learning, self-recognition, self-reflection, self-knowledge, self-control, self-started processes, and the corresponding deficits (see Ibáñez 2007). The study of reflection upon one's current experience has led to a closer study of MPFC (BA10), the medial prefrontal cortex (see Lieberman 2007). This is the region of the PFC that is disproportionately larger in humans than in other primates. For this reason, a biological reductionist might propose calling ourselves *batens*, or owners of the BA10 region. But sociological reductionists might then argue that our species deserves to be known as *Homo credulus*, as it gulps indoctrination to worship cruel gods and trust deceitful politicians. Wild animals are not as easily duped because they are not trapped by ideology and advertising.

Besides, recent research has cast serious doubts on the existence of a particular part of the human brain in charge of sociality (Singer 2012). Apparently nearly all of our brain is social, even though one region specializes in feeling nociceptive pain (one's own), another in empathic pain, and so on. In the human brain, localization combines with coordination (Bunge 2010: 166 ff). This is why systemism, rather than either individualism or holism, is the ticket (Bunge 1979).

The anomalous size of the BA10 region in humans, mentioned above, is related to the importance of internally focused processes versus externally focused ones. These differences may be compressed into the formula $M = S + B + SB + BS + BSB$, where M designates the intensity of mental activity, S that of the automatic response to an external stimulus, and B that of the spontaneous controlled mental process.

The combinations of the two main kinds of process are SB (exo-endo) and BS (endo-exo). SB stands for the environmentally biased mental

construction or moral deliberation, whereas *BS* represents action biased by intellectual or moral processes. Sensory deprivation may be symbolized as $S = \varnothing$, whereas $B = \varnothing$ stands for the blank state. Typically, sociological social psychologists stress *SB* processes, whereas psychological social psychologists focus on *BS* processes. However, both trends tend to treat *B* as a black box: only the neuroscientifically inclined among them dare open the box and look for the specific neural circuits that perform or affect the mental operations in question. The following section contains a few examples of each of the four categories.

Since none of the variables in question is well defined, the previous formula is so far only a mnemonic prop and heuristic device. Still, it also summarizes a whole research project: that of properly defining all three variables. In particular, *B* would presumably be defined in terms of such parameters as neuronal firing frequency and synaptic plasticity.

Another function of the same formula is that it encapsulates the two main classical alternatives to the current approach: $B = \varnothing$ or behaviorism, and $S = \varnothing$ or the mind-over-matter (or downward causation) doctrine. (In cognitive neuroscience, downward causation means either *cerebral cortex → rest of the body*, or *society → individual*.) See Figure 4. 1.

Externalism → servo arbitrio

Stimulus → black box → response

Extero-internalism → servo & libero arbitrio

Stimulus   Outward behavior

>Brain <

No stimulus   Mental processes

Fig. 4.1 Conditioned behavior/Free will.

The externalist school is that of Thomas Aquinas, Hume, Condillac, Mill, Watson, Skinner, and Vigotsky, whereas the internalist one is that of Plato, Augustine, Berkeley, Maine de Biran, Freud, Merleau-Ponty, Eccles, Popper, Chomsky, and Pinker. The extero-internalist school combines elements of the two previous ones. The philosophical concomitants of these schools are empiricism cum externalism, spiritualism cum internalism, and realism cum systemic materialism respectively (see Bunge 2017).

Many historians of philosophy assert that the formula "There is nothing in the intellect that was not previously in the senses" was invented by the British empiricists, in particular Bacon, Locke, and Hume. Actually that principle was held by all the schoolmen in the Aristotelico-Thomistic school. Secondly, Bacon stated explicitly that, far from resembling ants,

which only gather what they find, humans resemble honeybees, in that they transform into honey and wax the pollen they gather. Thirdly, Locke acknowleged that mathematical knowledge does not derive from sense impressions, which is why some Locke experts have called him a ratio-empiricist. Only Hume was a radical empiricist, as shown by his rejection of Newton's theories because they went far beyond appearances. And, because of his monarchical and racist opinions, Hume lagged in both politics and morals far behind the radical fringe of the French Enlightenment (see Israel 2014).

Clearly, social cognitive and affective neuroscience fits neither of the traditional philosophical trends, for it places cognition and emotion in the brain, and puts the brain in its social context. Thus, perception is sensitive to social pressure, but it is a brain process. Donald Hebb's classical experiments on sensory deprivation, and Jean Piaget's on the constructive nature of memory, learning and thinking, support the current view of the brain as a *tabula rasa* (blank slate) at birth, but thereafter as a creative organ, always ready to read, misread, or ignore external stimuli, as well as to imagine ideas of many degrees of abstraction. Anyone who has suffered hallucinations caused by a stroke will bear witness to the frightening inventiveness of a brain free from environmental controls. A free human brain is delirious.

It has been conjectured that each kind of mental process is performed by a neural circuitry of its own kind (Bunge 1980). The automatic processes, such as the unconditioned reflexes, proprioceptive sensations, tasting food, falling asleep and waking up, would occur in neural systems whose cellular components are held together by "rigid," or rather elastic, synaptic connections, some of which are inborn. In contrast, the plastic neural systems would be those where controlled processes occur – or, in the cryptodualist parlance of the day, they would "mediate" the learned patterns.

Roughly, Automatic = Inborn, and Controlled = Learned. However, the automatic/controlled distinction is not a dichotomy, for some automatic processes are plastic. For instance, children can be trained to control their bowel movements – something that chimpanzees cannot. Even the brainstem, a phylogenetically very old brain organ, is plastic. Indeed, the opto-kinetic reflex, which stabilizes images in the retina as the animal navigates in its environment, can learn to adjust to drastic environmental changes, such as confinement in a cage (Liu et al. 2017). Likewise, balance, which is controlled by the vestibular apparatus in the innner ear, can be lost and recovered by bioengineering devices.

It has become customary to say of brain organs that they *mediate* or *subserve* their specific functions, as in "brainstem neurons mediate (or subserve) innate motor behaviors." Another favorite is "neural *substrate,*" as in "the neural substrates of self-awareness." But if organ *A does B*, one should not say that *A* "mediates" *B*, or that *A* "subserves" *B*, for there are no intermediaries between organs and their functions, and the latter do not gratify their organs. Ordinarily we say that hands grasp, not that they "mediate" or "subserve" grasping. Talk of "mediation," "subserving" or "neural correlate" betrays psychoneural dualism.

Another rather popular expression is "instantiate". Actually, the visual system sees and the auditive one hears, just as legs do the walking and lungs the breathing. Likewise, it is wrong to say that the legs are the anatomical "correlates" of walking: legs just walk – though of course controlled by the motor centers, starting with the cerebellum. None of these parts of the body is a means to an end or goal, and none of them instantiates (exemplifies) a generalization. Straight talk is always preferable to circumlocution.

To understand a process we must find out *what* it is and *where* and *when* it occurs. The brain imaging techniques, such as fMRI, help solve the latter problem, that of site and timing. But to tackle the former problem, that of quiddity, neuroscientists must deploy all the physiological and biochemical techniques elaborated since the Scientific Revolution, along with the biophysical and biochemical ones invented since the start of the 19th century.

However, the study of the mental includes the organs outside the central nervous system that can influence it, such as the gut, which contains more than 100 million neurons. It has recently been discovered that these neurons connect the gut microbiota with the brain, to the point of altering the mood. Unsurprisingly, neurogastroenterology, or the study of such connections, is producing results of interest to psychiatry, in particular the study and treatment of depression. Who, in the spiritualist camp, would have suspected such a connection between the lofty soul and the lowly gut? However, let us return to the brain-society nexus.

To find out the mechanism of social isolation, and thus that of social reinsertion, it has been found necessary to follow the trajectory of dopamine molecules in and out of the dorsal raphe nucleus in the brain stem – the cusp of the spinal cord (Matthews et al. 2016). In turn, the uncovering of that trajectory involves the electrophysiological techniques invented in the mid-19th century by Emil Du Bois Reymond. Incidentally, this outspoken materialist and atheist started his scientific career studying electric fishes – a subject that most short-minded academic administrators

would find unpromising and thus unworthy of support: they never heard of hidden connections or of unanticipated events.

Let us next list a few typical findings of social cognitive neuroscience – an exercise that should emphasize how much the *neuro* approach to the mental and behavior contributes to transforming the *psycho* black box into a translucid *neuro* box allowing us to peek into its mechanisms.

1/ *Spontaneous processes.* Spontaneous or self-started processes are those that occur without any external inputs. Feeling a headache, dreaming, having a sudden idea, and exercising free will are familiar examples of processes of this kind. Presumably, they are not localized or, better, they may occur in different brain regions. Moreover, although these processes are not stimulus-bound, most of them, in particular self-consciousness, pride, shame, trust, and the wishes to succeed and to be well thought of are likely to have been learned in the course of social interactions. In any event, they violate the stimulus-response schema and they are not "computed" either, so they are counterexamples to both behaviorism and information-processing or computational psychology. The latter is so primitive, that it has yet to find the neural "computations" that occur during actual numerical computations such as multiplication.

2/ *Automatic processes.* The raw perceptions and feelings, as well as the conditioned reflexes, are the best-known examples of this category. Pavlov's dogs that salivated upon hearing a gong strike which used to accompany the delivery of food, and Skinner's study of the pigeons that danced when their seed containers were filled, have been amply vulgarized, but only as late as the first half of the 20th century.

The mechanistic philosophers, from Descartes to La Mettrie, argued that all non-human animals are unfeeling automata – something that any pet owner would dispute. Margaret Mead claimed that Samoans feel no emotions, but nobody shared this extravagance. Some present-day philosophers, namely the upholders of the computer or information-processing psychology, such as Hilary Putnam and Jerry Fodor, adopted the same view, though replacing the mechanical automaton, such as Vaucanson's ingenious duck, with the electronic computer.

The computer view of the mental is at variance with the well-known facts that computers work only when fed algorithms, that emotions are notoriously unruly, and that social life evokes such emotions as empathy, fear, compassion, love, and hatred, all of which occur in neural networks involving the amygdala, a subcortical organ likely to have emerged much earlier than the neocortex, and whose volume correlates with social

network size and complexity (Bickart et al. 2011). In general, whereas the tendency for personal electronic gadgets is to miniaturize, neocortex size has been increasing with group size (Dunbar 2009). In any case, the computational view of the mental overlooks the elementary facts that spontaneity and creativity are as unprogrammable as emotions.

Novelty detection is another subject of contemporary research, which engages not only psychologists but also roboticians. Among non-human animals, a novelty cue is a sign of danger, hence a source of fear and a warning to flee or freeze. In contrast, among humans and other higher vertebrates, novelty provokes curiosity as well as caution, and sometimes it motivates investigation, which may garner new knowledge.

It is currently believed that the hippocampus is the main novelty detector in humans. In any case, we are getting close to learning why some animals are neophilic whereas others are neophobic. The eventual impact of this research on political psychology should be obvious, as long as we do not forget that vested interests, which escape neuroscience, contribute powerfully to shaping political attitudes. This is why it would be foolish to engage in neuropolitics.

3/ *Controlled processes.* Imitation has been one of the best-studied mental processes since Gabriel Tarde's once-popular book on groupthink (1890). Imitation research received a sudden boost when Giacomo Rizzolatti and colleagues (2004) at Parma University discovered the mirror neurons in the macaque's inferior parietal cortex. Since then, similar neuronal systems have been located in humans and in some birds. These studies have confirmed the hypothesis that simians and other species possess a "theory of mind" – the misnomer that David Premack and Guy Woodruff (1978) gave the ability of imputing feelings and beliefs to others. A rough equivalent is the *Verstehen* or empathic understanding that Wilhelm Dilthey imputed to the students of social matters.

Of course, it is wrong to call *theory* the capacity to understand the minds of others. So far, it is only an ability waiting for a theory. And it is not obvious that a synonym for 'empathy' is really needed. What is clear is that the ability in question is not mind reading but "reading," or rather interpreting, outward or behavioral *indicators* of mental processes. Such studies have not only enriched animal psychology but have also enhanced our respect for monkeys and domestic dogs, as well as our admiration for Darwin's attribution of empathy to nonhuman animals.

Further investigations of the neural sources of empathy using functional magnetic resonance imaging have revealed the participation of much more than mirror neurons. Indeed, the spontaneous, intuitive or

preanalytic understanding of the minds of others is so important in social transactions, that in humans it engages no less than five brain "areas" (Preston & de Waal 2002).

Moreover, empathy is so strong in Capuchin monkeys, that they can go hungry to prevent electric shocks to conspecifics. Human infants too give signs of distress when seeing or hearing other babies in distress. The level of distress decreases with age, but in compensation the readiness to help other children increases. The school bully inspires fear but makes no friends, though he makes sycophants.

Granted, Stanley Milgram's (1963) sensational experiments seemed to show that most males enjoy watching others being tortured. However, this was not Milgram's point: what he showed is that fear of authority can trump fellow feeling. A similar point was made by the hugely sucessful German play and film "The captain from Köpenick" (1931, 1956) where a humble shoemaker masquerades as a Prussian officer and, as he marches in full uniform through a small town, gathers a growing following who take over City Hall, and "confiscate" the money in its coffer. The idea is of course that the good German citizen at the beginning of the 20th century was eager to obey commands from individuals who look like they hold high office. Could anything similar happen today in Washington DC?

Finally, let us not forget that $B \rightarrow S$ processes can be exaggerated to the point of delusions of grandeur. Berkeley's famous formula "To be is to be perceived" is a case in point, for it subjects the entire world to the perceiving subject. Social constructionism is a recent version of that delusion, for it views everything social as a product of the ego (see Bunge 1999). For instance, according to the "social model of disability," the latter is "wholly and exclusively social" (Oliver 1996).

Thus, even quadraplegia and Down syndrome would be only in our minds; and, being social constructions rather than medical conditions, the remedy for them would be a radical transformation of society – that is, waiting for that to happen rather than trying to help right now, for instance through brain prostheses translating thoughts into actions, or teaching manual skills to retarded youngsters. Fortunately, Anastasiou and Kauffman (2013) have disabled that defeatist offshoot of social constructionism.

4/ Exo-endo processes. Religiosity is a classic case of the *SB* kind. Lucien Lévi-Bruhl's bestseller (1922) was the earliest if failed attempt to characterize what he called "primitive mentality," and to explain it as an adaptation to the imagined environment of our remote ancestors. The

speculations of the recent evolutionary psychologists have been much more detailed but equally groundless.

Surprisingly, the first scientific investigation of the religiosity-societal health correlation in the prosperous democracies was published only recently (Paul 2005). It found that "the United States is almost always the most dysfunctional of the developed democracies, sometimes spectacularly so, and almost always scores poorly," while at the same time it is the most religious and also the most inclined to reject evolutionary biology and other scientific achievements. In contrast, Japan, Scandinavia, Belgium and France are the most secular nations, and at the same time some of the most egalitarian.

Data-driven research is another instance of a thought process initiated by a striking observation of the environment – that is, one that clashes with received wisdom or just fills a gap in our body of knowledge. The end product of this process is also known as a chance discovery or lucky finding.

Actually there is an element of luck, good or bad, even in the most carefully designed observation or experiment, as we are always bound to miss some variable or other. In addition, it is well to keep in mind Louis Pasteur's wise remark that "*Chance favors* only *the prepared mind.*" For example, the ancient Chinese astronomers-astrologers described and admired the extremely brilliant variable star Eta Carinae, but only recently have we learned that it is actually composed of two stars with a total mass of about 100 solar masses, and that its colossal explosions result from nuclear reactions in their interior.

5/ Endo-exo processes. All the free rational choices and decisions, as well as the resulting actions, are spontaneous or self-initiated processes in the prefrontal cortex. One of the most familiar experiences of this kind is free will, that is, volition not controlled by external stimuli, as when, after careful consideration, we follow a course of action congruent with our moral principles, even if we realize that it is likely to harm us. The most outstanding recent cases of this kind were the Buddhist monks who set themselves on fire to protest the American war in Vietnam.

The free will hypothesis lies at the intersection of theology, philosophy, psychology, and neuroscience. Indeed, for Augustine of Hippo it was part of the problem of evil: is it inherent in the world, or an aspect of free choice? For most philosophers, this problem is related to the determinism/indeterminism dilemma (see Rescher 2009); for Hebb (1949), it is a psychological problem amenable to experiment; and some neuroscientists are interested in it as an example of the spontaneous

activity of the central nervous system (see, e.g., Ibáñez 2017), hence a counterexample of both behaviorism and computational psychology.

Hypothesis-led scientific research belongs to the same $B \rightarrow S$ category. Indeed, the projects of this kind are backed not only by the usual philosophical presuppositions, such as realism and rationality, but also by specific guesses, such as the possible binding of the molecule being investigated with special receptors on the membrane of the target cell. Such assumed specificity guides the research, which is then anything but an erratic trial-and-error search.

Presumably concussions, strokes and other brain lesions, as well as deficits in neurotransmitters due to malnutrition or excessive alcohol consumption, translate into abnormal mental or behavioral symptoms, from apathy and recent memory deficits to poor scholastic achievement and disastrous political policies and actions.

A pioneering investigation of the strong negative correlation between malnutrition and abnormally thin cortex thickness, and the corresponding poor scholastic achievement of deprived Mexican children (Cravioto et al. 1966) was revealing. Later studies (e.g., Lipina 2016, Gabrieli & Bunge 2017) corroborated that finding and added numerical precision – for example, children in high-poverty school districts score four levels below their peers in the wealthiest districts. So, education is not the great equalizer, but equality facilitates education.

The work of the US National Scientific Council on the Developing Child, which began in the 1990s, not only made additional contributions to our understanding of our knowledge of the dependence of brain development on socioeconomic status. They also confirmed the variability of human nature, as well as the role of science in the detection of social issues and the elaboration of social policies to resolve them (Navarro and Muntaner 2014).

6/ *Exo-endo-exo processes.* In addition to the unidirectional processes listed above, we have loops of the *SBS* type. An obvious case of this kind is the *hurrah* shout expressing the joy felt when watching a goal score made by our favorite soccer team. Its dual, *Schadenfreude*, is socially and morally very different from healthy joy, but presumably it engages the same neural systems in addition to the vocal one.

Another familiar case of an *SBS* loop is the so-called Thomas theorem. This is summed up in the formula "People do not react to facts but to the way they perceive facts." For example, we often buy merchandise, or vote for politicians, whose "image" has been manufactured by publicity agencies that have embellished the product in question. In other words,

some of our actions are driven by false beliefs, and sometimes we guess that others too are fooled in like manner. This explains why the poor have recently elected billionaire presidents in a number of nations – a fact that, incidentally, has dashed the hypothesis that electoral results match class structures, as well as Mikhail Bakunin's hope that the next social revolution would be led by the underclass.

Until recently, it was thought that the ability to impute others false beliefs is specific to humans and, moreover, one that emerges only after the fourth year of life. Recent work by Michael Tomasello's team (Krupenye et al. 2016) suggests that younger infants, as well as three species of great apes, can anticipate that conspecifics will act guided by false beliefs. This finding also suggests that the tacit distinction between truth and falsity is several million years old rather than a recent philosophical invention. So much for Nietzsche's vitalist slogan "Let life be, and let truth perish."

Lastly, let us peek at the popular belief that "chronic raiding and feuding characterize life in a state of nature" (Pinker 2011). This opinion, first voiced four centuries ago by Thomas Hobbes, and popularized in recent years by armchair evolutionary psychologists, has been challenged by anthropologists such as Fry and Söderberg (2013), who studied 21 mobile forager bands distributed among four continents. They concluded that "most incidents of lethal aggression can aptly be called homicides, a few others feud, and only a minority warfare."

To sum up, every human could adopt Maurice Ravel's self-evaluation: "*I am artificial by nature.*"

Conclusion

In conclusion, the simian brain is highly social, and some regions of it are more susceptible than others to social stimuli. But, as Hebb's sensory deprivation experiments in the 1950s showed, the waking brain is active all the time even in the absence of external stimulation, though if shielded from its environs it tends to hallucinate. The normal brain interacts with its immediate environment as well as with the rest of the organism. This finding suggests that psychology is a biosociological discipline rather than either a chapter of zoology, as biologism has it, or a purely social science, as sociologism imagined. In fact, the recent trend in psychology is towards merger or convergence rather than towards independence, let alone plain reduction. What we are seeing in contemporary psychology is *ontological reduction* (of the mental to the neural) together with *disciplinary integration* – just what William James (1890) presaged.

5. THE STUDY OF EARLY SOCIETIES

Anthropology may be regarded as the basic social discipline, that is, the one upon which all the other studies of humans are based (Bunge 1985, 1998). This study can be speculative or scientific. The former approach is ancient and now pursued mainly by phenomenologists, none of whom are interested in finding out what people do to support themselves, face the so-called elements, or resolve conflicts of interest: its focus is the symbolic or cultural in the sociological sense of this word. In contrast, scientific anthropologists rely on fieldwork and testable theorizing about the many facets of human life, from the biological and economic to the political and cultural.

Scientific anthropology was started by the American lawyer and businessman Lewis H. Morgan (1818-1881), the first to conduct field studies of the Iroquois, whose language he learned. These were and are aboriginals who inhabited upstate New York, Quebec, and Ontario. They farmed and hunted, and practiced democracy, including sex equality. They still do it, as I saw when I hired a crew of Mohawk tree experts to extract the roots of a gigantic tree felled by a storm.

Morgan's study was hailed with alacrity by Marx and Engels, because it was the first to show that social equality is possible and, moreover, compatible with the pursuit of material welfare. Obviously, the studies of Morgan and his successors were totally different from the armchair inventions of the philosophical anthropologists, from antiquity to Max Scheler, Karol Wojtyla (the future pope), and Paul Ricoeur, all of whom pontificated on behavior and inner life without taking the trouble of reading the findings of their scientific counterparts.

The earliest archaeologists have been faulted for being antiquarians rather than historians, and treasure-hunters rather than scientists; for having extruded artifacts from their original environment; for failing to reconstruct the daily lives of the makers and users of ancient artifacts; for having privileged the symbolic – in particular artistic and the ritual – at the expense of the utilitarian; for having been describers, classifiers and cataloguers rather than social scientists driven by imaginative hypotheses concerning the way our remote ancestors may have lived, felt, and thought; and for not having respected the role that archaeological remains may play in preserving the historical records of contemporary peoples,

such as the Amerindians – records overlooked by the Eurocentrists like Hegel, who called the early societies "peoples without history," because they did not leave chronicles of rulers, dynasties, and conquests.

The fact that the scientific and the speculative approaches to the early societies are mutually incompatible does not entail that the former are non-philosophical. For instance, both Marvin Harris (1927-2001) and Bruce Trigger (1937-2006), the two giants of twentieth century anthropology, were keenly aware that their work was inscribed in a philosophical matrix.

I first contacted Harris when he wrote to me from Columbia University to congratulate me on the materialism without dialectics that I had sketched in my *Scientific Materialism* (1981). At about the same time I met Trigger in his office at the same McGill University building as mine. We struck up a friendship that lasted until his death from cancer in 2006.

1. Trigger's Philosophy

In his methodological papers Trigger adopted explicitly materialism, systemism, and realism. He had learned his materialism from the Marxist archaeologist Gordon Childe, whom he admired at a time when it was politically incorrect to even mention Marxist authors. He himself (Trigger 2006b: 234) told us about his ambivalent reaction to Childe's 1958 great work *The Prehistory of European Society*: "I was delighted by Childe's argument that the theoretical focus of archaeology should not be on culture but on the comparative study of prehistoric social and political organization. I was dismayed, however, by his frank admission that he could not discover how such studies might be done."

Trigger's later "undogmatic reading of Marx" included awareness of two of Marxism's weakest spots: its dialectical mumbo jumbo and its lack of a scientific methodology, with the concomitant disregard for empirical evidence. In this regard, Trigger's philosophy was similar to that of Marvin Harris' (1979), the other giant of anthropological theory.

Trigger argued that "A materialist ontology and a realist epistemology provide the basis for studying human beings as biological entities, who were produced by long-term natural selection and use their cognitive and rational abilities to relate to a world that exists independently of them" (Trigger 2003a: 28). But of course Trigger adopted what Jean-Pierre Changeux (2009) calls an "instructed" materialism, one that has learned from modern science instead of remaining stuck in the past, when the only science deserving this name was mechanics.

Trigger also adopted the functionalist (or systemic) approach that he had learned from Grahame Clark's 1939 path-breaking *Archaeology and*

Society. Actually, functionalism blends two mutually independent theses: (a) all the traits of any given culture or society are interdependent; and (b) every bit of culture, even the silliest ritual, has an adaptive function. Thesis (a), stressed by Bronislaw Malinowski, characterizes systemism, whereas thesis (b), emphasized by Émile Durkheim, is teleological. One may adopt either thesis without its accidental companion.

In either version, functionalism rejects the internalism that had characterized traditional archaeology (as well as the historiographies of art and of ideas). Internalist archaeology focuses on artifacts – tools, utensils, artworks, earthworks, and the like—and disregards or minimizes their functions, that is, the ways they were used and the way of life of their users. Internalism is the approach of the collector or the grave robber rather than that of the social scientist. By contrast, Grahame Clark had placed the artifact in its social context: it was social archaeology–without being purely externalist, though.

This is how Trigger characterized Clark's approach: "He maintained that archaeologists should aim to determine how human beings had lived in prehistoric times by reconstructing as far as possible their economies, their social and political organizations, and their systems of beliefs and values and trying to understand how these different aspects of culture related to one another as parts of functioning systems" (Trigger 2006: 354). In the same book (p. 355) he reproduced Clark's striking "systems diagram" showing the said interdependence as well as the ultimate source of survival, namely food supply.

What a far cry from the idealist emphasis on belief and ritual, revived in our days by Ian Hodder's learned papers and Clifford Geertz' popular books! And how much more refined is the Clark-Trigger version of materialism than Marvin Harris' cultural materialism, which was actually a clever symbiosis of functionalism and biologism with Marx' economic determinism! And yet, ironically, Harris was more interested in dealing with esoterica, such as food taboos, than with basic activities such as farming. (These two eminent scientists and philosophers of anthropology wore their theoretical differences on their sleeves: Whereas Harris was ebullient, loud, and beer-loving, Trigger was calm, soft-spoken, and austere. To indulge in stereotyping: whereas Marvin was a typical Brooklyn boy, Bruce was a product of an obscure Ontario town.)

Let us finally turn to the epistemological component of Trigger's philosophy. He was an uncompromising epistemological realist, at a time when realism was retreating in the Anglo-Saxon academy. Trigger's realism is anything but the naive realism that characterized Aristotle, and which is hardly distinguishable from the empiricism (or positivism) of

Hume, Locke, Comte, or Engels. Indeed, Trigger knew well that conceptual knowledge is needed to "make sense" of the world, and that even unrealistic ideas, such as religious fantasies, may discharge social functions (Trigger 2003b).

The editors of Trigger's first *Festschrift* (Williamson and Bisson 2006) called Trigger's epistemology "theoretical empiricism". I disagree with this characterization because empiricism is by definition anti-theoretical. I prefer "scientific realism", an amalgam of realism and scientism. I suggest that Trigger was a scientific realist, because he held that scientists attempt to model reality, and that they do so by adopting the scientific method.

Unlike the dialectical materialists, Trigger (2003b) distinguished materialism, an ontology or metaphysics, from realism, an epistemology or theory of knowledge. This distinction is important because the two doctrines are logically independent from one another. For instance, one may admit that making one's living takes precedence over understanding the world, yet one may deny that it is possible to understand the world. That is, one may be an obscurantist materialist, or mysterian, in tune with postmodernism – which of course Trigger despised.

Last, but not least, Trigger the anthropologist was a humanist. Not only did he adopt a secularist approach to research: he also felt respect and sympathy for his subjects. Moreover, Trigger practiced participant observation, to the point that his aboriginal hosts, the Hurons, adopted him and nicknamed him The-Turtle-Who-Knows – a slow but wise learner.

The humanist approach should not be taken for granted in the social sciences, given the arrogance of the traditional anthropologist who descended upon the "savages" from the heights of Cambridge, Paris, or Berlin, and settled on the verandah of his residence, to interview the tribe's informant – who sometimes took advantage of the scientist's gullibility, as we know from the experience of Margaret Mead. Contrary to Hegel, who called the natives of the colonies *Naturvölker* and decreed that they were "peoples without history," Trigger found that the aboriginals had a past worth being disclosed, and he wrote the first history of the Hurons before colonization (Trigger 1976).

Trigger had been wise to do his graduate work at Yale rather than in a European university, where he would have been sent to Borneo, Madagascar, or some other remote overseas place to do his fieldwork. Bruce knew that there were unstudied aboriginals just across the river from Montreal, where he resided fom the day he joined McGill University. This choice may sound obvious to anyone ignorant of the fact that, when Trigger was a student, and even when I joined it in 1966, the Canadian intellectual culture was still colonial, to the point that the openings for

academic positions were announced only in the British *Times Literary Supplement*.

Still, there is a strange incongruence between the multidiciplinarity of archaeology-anthropology and its social organization, which until recently was arranged around prima donnas rather than teams. Even self-effacing individuals likeTrigger tend to attract a few isolated individuals instead of entire teams of field workers. This was understandable when the goal was to produce good reads like Margaret Mead's on Samoan adolescents, Napoléon Chagnon's on his fierce people, or Clifford Geertz's on cockfighting fans, but these writers do not tell us how those people supported themselves. Moreover, they forget that the earliest cave pantings represent hunters, not warriors or war prisoners.

To see products of scientific anthropology, one had better visit modest museums like the one near the Danish city of Aarhus – which exhibits the wheels that kept a traditional Kurd village moving – or the splendid Museo Antropológico in México City, which hosts a reconstruction of an Aztec community. Such exhibits are public manifestations of the silent search for truth that goes on inside the philosophical pentagon.

In the mid-twentienth century Louis and Mary Leakey made some sensational discoveries in the Olduvai Gorge, suggesting that the *Homo* genus emerged about 3.2 million years ago in Ethiopia – the "Out of Africa" hypothesis. At present, the most exciting paleoanthropological news is coming from teams of between a dozen and three dozen researchers scattered among a handful of different countries, and studying the remains of far more remote ancestors of ours. Thus, the issue of *Science* for November 3rd, 2017, informs us about three recent breakthroughs in palaeoanthropology: that the genus *Homo* has occupied Southern Africa from about 2 million years ago; that the first humans to reach America were likely to come via a Pacific Rim route around 17,000 years ago – a finding that trounced the "Clovis-first" hypothesis; and that exogamy, and the associated incest rules, had been practiced at least 34,000 years ago.

Six decades ago, the curator of the National Archaeology Museum in La Paz, Bolivia, tried to persuade me that the pre-Inca Tiwanaku empire had been the cradle of humankind 300,000 years ago. His succesors looked for evidence and found that Tiwanaku had flourished only one millennium ago. What prompted this turnabout? Presumably, the successors of the earlier curator had replaced wild speculation with a scientific outlook.

Lastly, back to Bruce Trigger. His more or less explicit philosophy was a synthesis of materialist and systemist ontology, realist and scientistic epistemology, and humanistic ethics. In the balance of this chapter I will

argue that this pentagon constitutes the philosophical matrix—or, to change the metaphor, the nest—of scientific research at its best: see Fig. 5.1.

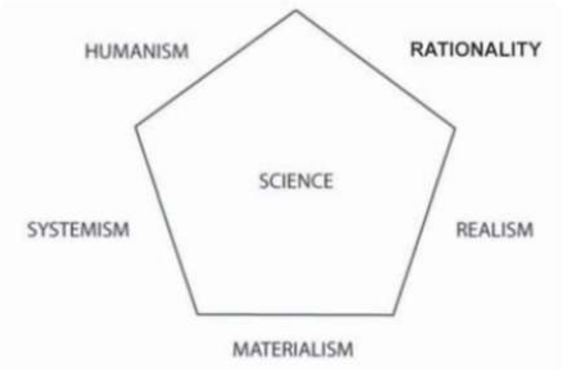

Fig. 5.1 The philosophical matrix of scientific progress.

2. The Role of Philosophy in the Birth of Modern Science

Why was science not born in China, the most advanced society around 1.600, when modern science emerged in Western Europe? Joseph Needham (1954), the pioneering student of Chinese science and technology, told us why: because at that time the Chinese intellectual culture was dominated by three ideologies that were indifferent or even hostile to the study of nature, namely Confucianism, Buddhism, and Taoism. Confucius had taught that what matters most is peaceful coexistence and law-abidingness; the Buddha, that all is but transient appearance; and Lao-tzu, that inner contemplation and religious piety trump action. None of these sages encouraged people to explore the unknown, much less to improve the known: all three were uncurious and passive, whereas scientists and technologists are eminently curious and adventurous.

Something similar happened with the Náhuatl or Aztec worldview: it too was speculative and socially conformist, hence unfavorable to the emergence of science (León-Portilla 1956). True, Aztec astronomy was quite advanced, but it had narrow utilitarian goals, namely keeping a calendar for agriculture, plus astrology conceived of as divination of personal affairs. The Náhuatl were not interested in seeking secular and disinterested knowledge of the universe.

How and why did modern science emerge in a few Western European countries around 1600? We do not know yet for sure, aside from the fact that it was built by a handful of scholars, essentially the correspondents of

the friar Marin Mersenne, one of the craftsmen of the new mathematics and physics. We still lack a whole picture of the Scientifc Revolution because each historian of science has adopted a sectoral approach, looking at only one of the many antecedents and progenitors of the Scientific Revolution: the Renaissance, the Reform, the exploration and looting of the New World, the world-wide expansion of capitalism, the printing press and the accompanying spread of literacy, the new secular philosophy, and the efforts of a handful of geniuses working on new problems of knowledge.

From a systemic viewpoint (Bunge 1979), all of the above-mentioned factors were important, and what was decisive was that they operated at the same time. However, my task in the present section is to focus on only one of them, the new philosophy, because there is no consensus on either what it was or why it matters.

The Scientific Revolution is usually understood as a set of unusual discoveries and inventions that started a new and fruitful tradition. I submit that this construal amounts to starting at the end, since no scientific work can be started without first adopting or inventing an approach, designing both a project to tackle a well-stated problem along with a strategy to carry it out, and a system of values to assess its results. For example, the apparently trivial problem of finding the exact shape of a hanging chain (the catenary) engaged about a dozen scientists, among them Galileo, Huygens, Leibniz and Euler, during a full century.

All those research projects included typically modern idealizations, in this case modeling the real chain as a thin cable without links. And the final solution involved a mathematical function invented to solve that problem, namely the hyperbolic cosine. Even better, think of any of the far bigger problems posed by the "discovery" of America, such as the nature of its "savages" and their puzzling societies.

I take it that the Scientific Revolution resulted from desacralizing the world (to use Max Weber's apt phrase), and wanting to inventory, understand, and master it in purely secular terms and with the sole help of reason and experience. In sum, the novelties generated by the Scientific Revolution constitute but a link in the following chain attached to the existing knowledge:

Approach – Plan – Research – Results – Replication – Evaluation.

The official story is that the new science was a byproduct of the rejection of Aristotelian scholasticism. I submit that the authentic revolutions of all kinds are not restricted to removing the old: they also build new scaffoldings. In the case of scientific breakthroughs, such new

scaffoldings consist in original ways of posing and tackling epistemic problems, that is, in new research strategies.

For example, Copernicus fathered modern planetary astronomy when he replaced Ptolemy's study of individual planets with the investigation of the solar *system*. (But he kept of course two essential traits of Ptolemy's: his respect for observational data, and his use of mathematics – which reminds us that, Kuhn and Feyerabend notwithstanding, no revolution is total. See Barseghyan 2015 for some constraints on scientific change.)

In the succeeding century Harvey and Vesalius inaugurated modern human anatomy and physiology when they replaced the study of isolated organs with that of *systems*, such as the cardiovascular one. Newton was the first to view the universe as a *system* of bodies held together by gravitation. Quesnay and Leontief, separated by two centuries, earned fame by conceiving of the market and the national economy as *systems*, not just sets of producers, traders and consumers. Faraday and Maxwell thought of electric charges and currents, together with magnets, as *systems* kept together by electric and magnetic fields.

Darwin conceived of biospecies not as separate collections but as the branches of the tree of life – a system whose components are bound by the descent relation. Ramón y Cajal revolutionized neuroscience when he identified the units of the nervous tissue and revealed the networks or *systems* into which they combine. Rutherford and Bohr fathered modern atomic physics when they conceived of the atom as a *system* of particles rather than a tiny marble. Bernardo Houssay was awarded the Nobel Prize for proving that the pancreas and the hypophysis, though rather distant from each other, belong to the endocrine *system*. Donald Hebb, inspired by the work of Cajal and his school, renewed psychology upon postulating that what feels, perceives, thinks or evaluates are neither whole brains nor individual neurons but something in between: cell assemblies or neuronal *systems*. And Keynes created modern macroeconomics, as well as the socioeconomic policy that bears his name, by treating the economy of a region as a social *system* closely connected to the political system, rather than as an amorphous aggregate of free agents.

In all of the above-mentioned cases the innovation was centered on a *material system* rather than on either an isolated individual or an impenetrable whole: planets were no longer thought to be moved by angels, neuronal systems were not deemed to be controlled by immaterial souls, economies were not under the guidance of invisible hands, and so on. In sum, the makers of modern science tacitly practiced what I call *systemic materialism*, an alternative to both crass materialism (or physicalism), and dialectical materialism (Bunge 2006). The central thesis

of this ontology is that every real entity, whether atom or cell, animal or society, is a material system or a component of such. This kind of materialism does not eliminate the mind: it only regards mental processes as brain processes, and consequently as subject to normal scientific investigation. Nor does systemic materialism ignore or underrate the symbolic traits of cultures: it just conceives of them as products of humans living together, on a par with labor and social relations. However, let us get on with our story.

I further suggest that the Scientific Revolution consisted to a large extent in developing three capital aspects of Aristotelianism: rationality, realism, and the cautious materialism of Theophrastus, Alexander of Aphrodisias, Averroes, and the Latin Averroists. Indeed, the schoolmen respected logic although, as Bacon and other critics noted, they used it to dispute over the sacred scriptures rather than to explore the world. And, except for the nominalists – who were actually vulgar materialists – the schoolmen replaced naturalism with a moderate supernaturalism that did not interfere seriously with physics. For instance, Thomas Aquinas, in defiance of the establishment, promoted the study of Aristotle's physics, which kept no trace of supernaturalism.

Moreover, the medieval theologians did not challenge the epistemological realism inherited from Greek antiquity. The challenge came only when Copernicus and his followers proposed the heliocentric model of the planetary system. Since this model contradicted the book of Genesis, Cardinal Bellarmino and other Catholic theologians came up with an ingenious trick: *conventionalism* (or instrumentalism). According to this epistemology, scientific theories are neither true nor false, but only tools for making predictions. This was supposed to hold, in particular, for the heliocentric and geocentric models: both were (at that time) compatible with the extant astronomical data, so that a good empiricist had no reason to choose between them. In short, they were empirically equivalent models. Ironically, three centuries later Philipp Frank and other logical positivists resurrected this doctrine and thus tacitly approved of the Inquisition's pivotal argument against Galileo.

This episode illustrates the difference between realism and empiricism: whereas realists attempt to account for reality, empiricists – from Ptolemy to Bacon, Hume, Kant, Comte, Mach, Carnap, Reichenbach and Frank – stuck to phenomena or appearances, and are thus anthropocentric, since there can be no appearances without subjects This holds for the social world as well as for the physical one.

The fact that most empiricists have declared their love of science and have claimed to do scientific philosophy is beside the point: the point is

that empiricism is inimical to science because it is subject-centered, whereas scientists strive to be as objective as possible, and scientific philosophers are expected to enrich realism.

In summary, the progenitors of the Scientific Revolution practiced the rationality, naturalism (or even materialism), and epistemological realism inherited from Greek antiquity, as well as the systemism that emerged along with modernity. Let us take a closer look at these philosophical ingredients of modern science.

3. Materialism, Systemism, Dynamicism, and Realism

The Venetians knew that religious and philosophical tolerance is good for business, particularly for foreign trade, the source of their great wealth. For this reason they respected academic freedom at Padua University, which they funded and protected from the Inquisition. About 1600 its most famous professor was Cesare Cremonini (1550-1631), a colleague, friend, and rival of Galileo. He was the most famous and best-paid philosopher of his time, as well as a correspondent and protégé of several European princes (see Renan 1852). Cremonini was also a notorious heretic, whom Torquemada would have liked to burn at the stake because he was an outspoken materialist, realist and rationalist, as well as Aristotle's faithful follower. Cremonini was popular among the Paduan students for denying the immortality of the soul and holding that reason trumps faith.

Which were Cremonini's contributions to the Scientific Revolution headed by his colleague Galileo and his former student William Harvey? None, except for the unfortunate role that Galileo assigned him in his soon to be condemned *Dialogue*. In fact, Cremonini served him as a model for Simplicio, one of the two schoolmen who refused to look at the Sun and the Moon through his telescope. Why bother looking at them, if the Philosopher had described them as perfect spheres, whereas Galileo claimed that the Sun was spotted, while the Moon' surface was blemished by craters? (Today's analog: the philosophers of mind who refuse to look at cognitive neuroscience, the vanguard of psychology.)

A moral of this episode is that, to engage in scientific research other than routine work, materialism, realism and rationality are insufficient. That is, it is not enough to deny the existence of disembodied spirits, to assert the reality and knowability of the external world, or to abide by reason rather than authority, revelation, or intuition. To do good science it is also necessary to adopt the scientific method, that is, to check one's conjectures against the relevant data as well as with the theories enjoying a

good track record. In short, respect for fertile theory and replicable evidence are necessary for doing good science.

Nor is trust in the scientific stance enough to do grand science: a systemic approach too is required. That is, one must try and place the object of inquiry in its context instead of isolating it from its environment. For example, we honor Walter Cannon, Hans Selye and their successors for having built the interscience that studies the supersystem constituted by the brain and the endocrine and immune systems, namely psycho-neuro-endocrino-immunology.

Further recent interdisciplines are cognitive neuroscience and evolutionary developmental biology, or evo-devo for short. Similar fusions have emerged in the social sciences in recent years, such as socioeconomics and political sociology. (Sociobiology and its successor, evolutionary psychology, do not count because they are failed attempts to reduce social science to biology.)

All of the above-mentioned fusions, and then some, were effected one century after the birth of physical chemistry (or chemical physics), biochemistry, biophysics, and social medicine (née social hygiene). In sum, it has become increasingly clear that all the disciplinary barriers are largely artificial, because the universe is the system of all systems. The methodological consequence is that the specialization or disciplinary division process must be balanced by a parallel process of progressive fusions: from trunk to branches and vice versa (Bunge 2003a). See Figure 5.2.

Fig. 5.2. Increasing specialization (analysis) is balanced by ever broader integrations (syntheses). From Bunge 2003.

We meet systems wherever we look for them. In physics we study systems from atom to galaxy; in chemistry, from molecules to systems of chemical reactions; in social science, from family to international organization; and in engineering, from nut-and-bolt couple to jet engine. With concrete entities, so with abstract ones, such as groups (e.g., the CGS system of units), spaces, systems of equations, and hypothetico-deductive systems. An explicit systemic view will help us see interdependence beneath a collection of isolated items, and thus the individual item as the member of a whole constricting it in some regards and expanding its reach

in others. Suffice it to contrast the unemployed homeless with the employed family man.

Systemism entails dynamicism (or process ontology), because every interaction causes changes, both internal and external. Dynamicism is contrary to the Platonic worldview, according to which the basic constituents of the world are immutable, disembodied and eternal ideas. Ironically Plato, an objective idealist, gave the correct definition of 'material' as 'changeable' (or 'corruptible', in his hierarchic worldview). Any materialist who admits this identity of materiality with changeability will be a dynamicist. In particular, biologists will think in evolutionary terms, anthropologists in terms of biosocial evolution, and historians in terms of interacting and evolving social groups such as bands, nations and blocs.

A dynamicist ontology will favor the search for laws of change as well as for the mechanisms of complex things, that is, their characteristic processes, such as reproduction, work, and trade in the case of human groups. It is no accident that Machiavelli, the founder of modern political science, explicitly criticized Plato's thesis that whatever changes is imperfect. Machiavelli saw society in constant change. Nor is it accidental that Galileo sought the laws of motion both experimentally and mathematically instead of repeating the beliefs of his predecessors. Since then, the kernel of any advanced scientific theory is a set of equations of change. Since then, too, nearly all scientists expect that today's best theories will eventually be perfected or replaced: only unreconstructed Marxists, orthodox economists, and arrogant physicists believe that their own theories, or at worst the next ones, are or will be final. Scientism involves both moderate skepticism about current knowledge, and meliorism, or trust that future research is bound to produce new and more accurate or deeper knowledge – impossible according to radical skepticism (see Bunge 1991).

4. Scientism and Humanism

To innovate in the young (or "soft") sciences it is advantageous to adopt scientism. This is the methodological thesis that the best way of exploring reality is to adopt the scientific method, which may be boiled down to the rule "Check your guesses." Scientism has been explicitly opposed by dogmatists and obscurantists of all stripes, such as the neoliberal ideologist Friedrich von Hayek and the "critical theorist" Jürgen Habermas, who managed to amalgamate Hegel, Marx, and Freud, and

tried to shift the focus of social science from work, mutual help and struggle to "communicative action," that is, talk.

Lalande's sober *Vocabulaire* (1938: II, 740) gave the following definition of 'scientism': "it is the idea that the spirit and the methods of science ought to be extended to all the domains of intellectual and moral [social] life without exception." Thus, contrary to its detractors, scientism is not the same as social naturalism, or the attempt to ape the natural sciences in the social domain: it is only the attempt to use the scientific method in dealing with all the problems concerning facts.

Scientism is opposed to irrationalism, in particular intuitionism and mysterism–the claim that there are mysteries, such as the nature of matter and the mind, that science will never solve (e.g., Chomsky 2009). But also those who try to pass off their groundless speculations for scientific findings reject scientism. This is the case with the selfish gene idea, memetics, psychological nativism, and speculative evolutionary psychology, or the attempt to explain everything social in exclusively biological terms, thus overlooking the fact that there are social inventions, and that some of these – such as warfare and some kinship rules in pristine societies – are detrimental to life.

Obviously, scientism is necessary but insufficient for scientific progress. Indeed, the scientific method may be used to handle uninteresting or even ridiculous problems, that is, problems with trivial solutions, or that ignore well-known pieces of knowledge. This is the case with the publications in scientific journals that have earned the Ig Nobel Prize, awarded yearly to ten ridiculous papers. The following are among the findings that deserved the prizes awarded in 2008: dog fleas jump higher than cat fleas; armadillos may disorder the contents of archaeological sites; the more expensive placebos are also the most effective; hair tends to get tangled; and plants have dignity. As Molière said, a learned fool is even more foolish than an ignorant one.

Last, but not least, scientific progress also requires observing the moral norms that regulate the search for truth. This is because scientific research is a social endeavor, since it involves cooperating in some respects while competing in others. In fact, even the most reclusive of investigators utilizes findings of others, and in turn feeds his readers intellectually. And, to avoid purey destructive conflicts, all social transactions must follow norms of coexistence, which are moral norms. For example plagiarism is more strongly condemned in the sciences than in the humanities, because teamwork is more common in the former than in the latter.

In a classical article, the founder of the scientific sociology of science (Merton 1975: 259) showed that basic research is ruled by the following

moral norms: intellectual honesty, integrity, organized skepticism, disinterest, cognitive communism, and impersonality. I would add only a few more: cooperating with peers and students rather than exploiting them; combining research with teaching; promoting the free and fair competition for grants, students, and jobs; tackling issues whose research may annoy the powers that be; telling the truth even if, indeed particularly if, it contradicts the ruling worldview; popularizing science and scientism; denouncing pseudoscience and obscurantism; and abstaining from using science to harm people – the ultimate goal of research funded by armed forces.

By the way, let us no blame scientists for the military uses of their findings, because weapons are designed by engineers and manufactured by factories managed by businessmen and military leaders, who sometimes work in cahoots with criminal politicians. For instance, Enstein did not design the nuclear bombs that President Truman ordered to be launched on Hiroshima and Nagasaki. But, to his credit, eventually Einstein repented his tiny if decisive part in that heinous crime, and did not tire of repeating that basic scientists search for truth, not riches or political power. Al Capone's *mamma* Teresina did not beget a monster, but little Al's teachers cannot be let off lightly.

5. Philosophical Pentagons: Regular and Irregular

The upshot of the preceding is that the search for new and important truths about reality involves a more or less explicit commitment to the philosophical pentagon made up of rationality, realism, materialism, systemism, and humanism: recall Figure 5.1.

I submit that Galileo and his disciples, as well as Kepler, Harvey, Huygens, Boyle and other founders of modern science adopted the philosophical pentagon in a tacit way. Descartes only missed realism, since he never bothered to look for empirical evidence for his fantasies about the ubiquitous whirls. Much closer to us we find at least five great scientists who adopted the pentagon and changed the dominant worldview: Darwin, Cajal, Rutherford, Einstein, and Keynes – four natural scientists and one social scientist. (However, it may be argued that Marx came close, and would have qualified, had it not been for his residual Hegelianism and his love of prophecy.)

Why that asymmetry between social and natural scientists? It cannot be a matter of age, because the social sciences, starting with historiography and politology, are just as old as the natural ones. Could it be instead because telling the truth about social issues takes more objectivity,

independence and civil courage than telling it about nature? Or might it also be due to the fact that many students of society were strongly influenced by philosophers who, like Kant, Dilthey, Rickert, Bergson, Husserl, Gadamer, Ricoeur, Habermas, Putnam, and Taylor, denied the possibility of understanding society through the scientific method? This is a subject for a different investigation (e.g., Albert 1994, Bunge 1996.)

In most cases, the sides of our philosophical pentagon in Fig. 5.1 are not equal: sometimes materialism is short, in other cases realism is insufficient, and in still others humanism is weak. For example, until a century ago many biologists were vitalists; many students of society succumbed to Kantian subjectivism; and most nineteenth-century physicists opposed the atomic hypotheses proposed by chemists. Even today, one may find nativist psychologists and social students who prefer hemeneutic speculation to the scientific method.

Paradoxically, nearly all of the founders of microphysics, in particular Bohr, Heisenberg and Born, preached positivism while investigating entities that the fathers of modern positivism, from Comte to Mach, had declared nonexistent. In fact those scientific giants denied the autonomous or objective existence of the very objects they studied so successfully, namely atoms and their components: they extolled subjectivism and phenomenalism.

But of course those eminent physicists did not practice the philosophy that they extolled: they did not include the observer in their basic equations, and they admitted the reality checks performed in physics labs. In this case, a bad philosophy did not frustrate the ancient atomic project, of explaining the visible by the invisible. Likewise Newton praised inductivism in the same book, his monumental *Principia*, where he expounded the earliest fruit of the hypothetic-deductive method in natural science. It is involuntary duplicities like these that impelled Einstein to warn us that, to find out what scientists really think about science, one should look at what they do, not at what they say they do.

Something similar happened in the social sciences. Marx conducted original and important scientific research while praising Hegel's antiscientific philosophy. And, as Trigger (2006a) showed, a number of Marxists made original contributions to archaeology thanks to their materialist, systemic and scientistic approach. Much the same has been said of some Marxist historians (Barraclough 1979). After all, the past barks but does not bite.

A lesson is that sometimes the worst logical sin, namely inconsistency, pays. It does whenever a truth is unwittingly asserted together with its

denial, as when technological advancement is praised for facilitating daily life, while deploring the unemployment it generates.

6. The Skeptical Eye

It is no enough to promote and conduct rigorous research: it is also necessary to protect it from the pseudosciences, which sometimes infect the scientific community. Two examples must suffice here: nativism, or the myth of innate ideas, and economic orthodoxy, or the myth of the "rational" (utility-maximizing) consumer and the self-correcting market.

Nativism is the thesis that we are born knowing a lot – which suggests that its upholders never gave babies tests on any school subject. The ideological and political consequences are obvious: neither education nor social reform can correct social inequalities. Steven Pinker (2003), the most popular psychologist of his day, stated that "the new sciences of human nature," from genetics to evolutionary psychology, vindicate what he called the Tragic Vision. This is none other than the ferocious individualism of orthodox economics and conservative political philosophy. Pinker cited (op. cit.: 294), in particular, the following "discoveries" of those "new sciences": "the primacy of family ties"–despite the obvious fact that in most cases the members of business firms, political cliques, laboratories, regiments, and sports teams – are genetically unrelated; "the universality of dominance and violence across human societies"–even though the murder rate has been declining in all civilized societies over the past century, and that not even the most divided societies are basically tyrannical and violent; and "the universality of ethnocentrism and other forms of group-against-group hostility across societies"– as if such undeniable strife were not moderated by tolerance, law-abidance, and cooperation; and "the limited scope of communal sharing in human groups" – although social archaeologists found long ago that social stratification emerged only about five millennia ago, along with the state (e.g.,Trigger 2003b), and that primitives were foragers and scavengers rather than mighty hunters (e.g., Binford 1983).

Pinker's list of accomplishments of the "new science of human nature" reads like the preamble to a New Right Manifesto rather than a summary of scientific findings. Much the same applies to the self-styled evolutionary psychology (e. g., Barkow 2006), which espouses nativism even with regard to social stratification and warfare, and enjoys Pinker's enthusiastic support.

Our second example is the ruling economic orthodoxy, the theory taught by most economics professors—most of whom never foresaw any

economic crises. This is not the place to examine the specific assumptions of this theory (for which see Bunge 1998). Let us just recall the principles (a) that the only goal of economic activity is the pursuit of private profit; and (b) that the free (unregulated) market is self-regulating—always in equilibrium or near it, whence any governmental intervention is bound to hurt it. These hypotheses rest on three unexamined philosophical doctrines: an individualist ontology, a dogmatic epistemology, and an individualist ethics. Obviously, the theory in question does not fit our philosophical pentagon. No wonder that it has been accused of inspiring economic policies with disastrous socioeconomic consequences, such as the latest recession.

In sum, bad philosophies will nurture bad science, which in turn will suggest bad policies. See Figure 5.4.

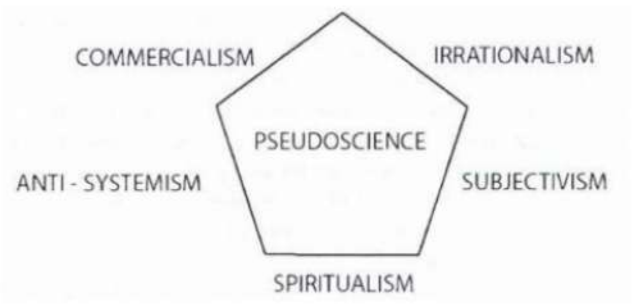

Fig. 5.4. The philosophical incubator of pseudoscience. From Bunge (2017), p. 158

Concluding Remarks

In conclusion, the philosophical "procreant cradle" of scientific research—as Shakespeare might call it—may be either a nest in which to lay and brood promising ideas, or a cage to prevent the flight of imagination. In other words, a philosophy may be progressive or reactionary accordingly as it facilitates or obstructs the advancement of knowledge (Bunge 2012b).

I have suggested that whoever does any productive scientific work practices a materialist and realist philosophy. Natural scientists have been doing this tacitly for half a millennium, so they have nothing to fear from the postmodernist fashion, which is nothing but an update of the Counter Enlightenment born about 1800. In contrast, the students of society and humanities are not immunized against that fashion. What can we expect from a student who takes seriously the spiritualist, subjectivist, and anti-systemic philosophy that Max Weber and Pitirim Sorokin preached but not

always practiced, whereas the phenomenologist Alfred Schütz and the anthropologist Clifford Geertz both preached and practiced?

For one thing, such a student would not bother to find out how people make a living and, a fortiori, she would not care for social statistics. This is because, being a spiritualist, she would be interested exclusively in ideas, pictures, games and religious ceremonies. For the same reason, she would be unable to understand expeditions or wars, since nearly all of these are motivated by the desire to get hold of natural or human resources. Nor would she understand the current economic crisis, since one of its causes is the fight of big corporations and their political helpers against all the regulations aiming at restricting their power over individuals. And, being anti-humanist, such a student would refuse to acknowledge that the most successful nations are those where the welfare state prevails. Lacking in true social theories and a humanist morality, our victim of pseudoscience would favor mean socioeconomic policies that, in the end, would worsen the crisis of the old-fashioned capitalism that is currently in global crisis and threatens the open society, as George Soros (1998) warned a decade ago.

In summary, all scientific research is conducted inside a social framework and a philosophical matrix. If the social framework is broad and flexible – if it encourages innovation –, it will protect the people who are more motivated by curiosity and peer recognition than for profit and social prestige. And if the underlying philosophy is rationalist, materialist, systemic, realist and humanist, disinterested research may bear fruit – otherwise it is likely to produce pseudoscientific garbage. Consequently those in charge of designing cultural policies would do well to protect the philosophical pentagon.

6. Reframing Mental Disorders

A contemporary psychiatrist might feel at home in the surgery of the central character of Machado de Assis's novella *O alienista*, published in 1882. This masterpiece was not only the founder of Brazilian fiction: it also painted a realistic picture of the psychiatry of the time, which relied almost exclusively on self-reported symptoms – nearly like ours. Whence the frequent misdiagnoses, such as homosexuality, bedwetting, tics, and going on strike as mental disorders, which affect 38% of the population. (Freud claimed that strikers rebel against managers because they regard the latter as their "father figures." The Oedipus myth delivers instantly what would take social scientists many days' fieldwork. Freud also treated Princess Andrew of Greece and Denmark, explaining her delusions as a result of her sexual frustration, and prescribed X-raying her ovaries to kill her libido.)

One major reason for wrong psychiatric diagnoses in the past was the lack of suitable instruments such as fMRI (functional magnetic resonance imaging), or the failure to use existing instruments, such as X-rays, which would have detected cerebral tumors instead of the sexual dysfunctions invented by Charcot and his disciples – among which Freud and Jung stood out.

The best data those psychiatrist could get, aside from interrogations, questionnaires and reports on ostensive behavior, were the ones garnered by pathologists, who could only examine either slices of dead brains through optical microscopes, or subject living cortices of wakeful patients due for neurosurgery to low-voltage electric currents – as Wilder Penfield, of homunculus fame, started doing in the 1930s. The non-invasive study of living brains became possible only after brain-imaging devices were invented in the early 1970s using a recondite finding in nuclear physics.

Towards the end of the 19th century, some of the most reputable European psychiatrists were seduced by Jean-Martin Charcot's fantasies on "hysteria" and his favorite cure for it, namely hysterectomy, or the surgical removal of the womb. Only if the presumptive insane patient was lucky to be male could he be spared such barbaric treatment. But the insane could be chained, forced into straitjackets, sprayed with cold water, or even be beaten up to be "tranquilized."

Nor were unreliable psychiatric diagnoses and barbaric interventions exceptional. In the 1930s and 1940s, thousands of mental patients were subjected to lobotomy, the surgical procedure that detaches the prefrontal cortex from the rest of the brain, depriving the patient of his/her willpower. Its inventor, the physician Antonio Egas Moniz, was awarded the Nobel Prize in 1949, when his operation had already been all but abandoned.

At about the same time, some political dissidents in the Soviet Union were diagnosed as insane and locked up in insane asylums. Needless to say, the very notion of patients' rights, that we use nowadays, had not even been invented at that time. And the madness criterion was the one used by general practitioners or lawyers, not by psychiatrists: any adult incapable of earning his keep through work could be declared mad – particularly if he was wealthy, confined to his bedroom, and at the mercy of greedy relatives with inheritance prospects.

It has recently been revealed that during World War II a number of German psychiatrists murdered at least 200,000 people, mostly children, diagnosed as retarded or mentally ill, hence of no use to the Nazi war machine (Gannon 2017).The main director of this vast euthanasia campaign was a Herr Doktor Julius Hallervorden, the wartime director of neuropathology at the prestigious Kaiser Wilhelm Gesellschaft, the German counterpart of the Royal Society of London.

The brain tissue samples of this "euthanasia" campaign were carefully preserved and studied by several generations of German psychiatrists. However, little is known about the dubious diagnoses of mental feebleness that were made to justify that vast operation, whose directors kept their jobs after the war. The extant slides are currently being studied with the support of the reputable Max Planck Gesellschaft.

The next episode of the dark side of the history of psychiatry was the MK-Ultra project of "mind control" financed by the Central Intelligence Agency and carried out between 1953 and 1964 at the Allan Memorial Institute, a part of McGill University in Montreal, Canada – the present author's academic home. The director of this project was the reputable physician Ewan Cameron, assisted by some of the best psychologists of the time (McCoy 2006).

The victims of those brutal treatments were ordinary mental patients who were not warned that they would be given high doses of LSD and amphetamines, which made some patients seriously sick, and permanently disabled others. One of those unwitting guinea pigs was Professor William Bunge, an American mathematical geographer and a relative of the present writer, who had to live out his precarious life in the Quebec wilderness.

However, let us go back to the central issue of this paper, namely the primitive state of psychiatry before the 1950s. In the vast majority of cases, the psychiatric diagnoses were based on the symptoms reported by the patients, such as headache, dizziness, chronic fatigue, hallucination, anxiety, low mood, or inability to recognize faces. In short, the psychiatric diagnoses were symptomatic: they did not involve objective biomarkers or indicators. Moreover, they were not accompanied by hypotheses about the possible neural mechanisms of the disorders in question, such as anatomical disconnections and the loss of the ability to synthesize certain neurotransmitters – which would have invited trying psychopharmacological drugs.

This confinement to symptoms or phenomena, or the restriction to "phenomenology," was largely due to the psychoneural dualism that most psychiatrists learned at medical school. That is, a main source of the flaw in question is not medical but philosophical. Indeed, medical students took it for granted that mental diseases are disorders of the supposedly immaterial soul, not of the brain. Hence they could be treated by logotherapies such as psychoanalysis, or even be attributed to social flaws such as social exclusion.

The idealist view of the mental ruled psychiatry until the end of the 18th century, when Philippe Pinel adopted the materialist hypothesis that mental events are brain events, and its medical corollary, that mental diseases are brain diseases, so that mental patients should be neither chained nor beaten. That is, Pinel was one of the forerunners of biological psychiatry, which included the humane treatments of mental patients.

However, biological psychiatry remained speculative until Paul Broca (1864) found the anatomical seat of speech, and Carl Wernicke (1874) that of the comprehension of linguistic locutions – or the transformation of words into concepts. Broca and Wernicke were thus pioneers of the scientific psycholinguistics of the healthy adult brain. While their work pioneered the scientific study of aphasias, it could not prevent some ridiculous diagnoses, like that of deaf-muteness attributed to a woman interned in a Parisian hospital, who eventually proved to be perfectly fluent in her native language, Arabic, to the surprise of the attending medics, who regarded French as the only possible language (Paradis et al. 1982).

Even those momentous neuroscientific discoveries were insufficient, for at that time mental diseases had no detectable anatomical, histological or physiological counterparts. For this reason Emil Kraepelin's crude if bold speculations about the neural "correlates" of mental diseases were

laughed at as a mere variation of the groundless speculations of the phrenologists, or readers of cranial bumps.

The phrenologists were not scientists because they did not check their fanciful mappings of the mind onto the brain, as James Olds (1975), of pleasure center fame, would say: they just imagined them – and charged for their speculations at fairs. Some philosophers of mind, notably Jerry Fodor, as well as the pop evolutionary psychologists, revived phrenology around 1980 as the modularity or Swiss-knife metaphor, according to which the mind is a collection of mutually disconnected specialized modules.

Localizationism was simplistic but not utterly wrong, for thanks to MRI and other brain imaging techniques we have learned, among other things, that the main visual system is located in the occipital lobe, the decision-making one in the prefrontal cortex, and so on. Still, in some cases such specialized centers are multiple, and in no known case do they act alone. For example, there are about twenty vision areas in the human neocortex, and the activation of any one of them may activate others.

Besides, in 1973 Ernst Pöppel, working at MIT, discovered blindsight, and a year later Lawrence Weiskrantz confirmed this astounding finding. This is consists in that some patients deprived of the striate cortex – the primary visual cortex – can still vaguely see shadows, edges and motions, though they are not aware of such percepts. It has been conjectured that these patients use an older visual pathway. Similar phenomena have been discovered in other sensory modalities. It is thus possible that our modern brains contain "fossils" of previous evolutionary phases, now dormant but able to resume active service in exceptional circumstances.

Thanks to electrophysiological studies, the brain-imaging devices, and Hebb's (1949) hypotheses on plastic cell assemblies, we now conceive of the brain, and even the whole animal, as "a union of loosely joined wholes" (Geschwind 1974: 225). In particular, we tend to view the brain as a system of subsystems joined by variable couplings, and thus capable of learning and inventing even without external stimulation (Bunge 1980, 2010).

Back to the central concern of this paper, namely psychiatric nosology. Note that, if mental functions and their dysfunctions are organic rather than spiritual, then they must be affected not only by the scalpel and the electrode but also by the ingestion of certain chemical compounds, namely the psychotropic ones, from coffee and beer to opium and Prozac. This has been known for millennia, and duly exploited by publicans and opium-den owners.

Given the knowledge that psychotropic drugs are consumed with the deliberate aim of altering mood or cognition, it is surprising that psychiatrists took so long in trying them on their patients. In fact, the lithium salts were first tried on bipolars as recently as 1948, and chlorpromazine was first used to treat schizophrenics only four years later. The use of these drugs caused a revolution in psychiatry, which marked the birth of a new science, psychopharmacology, along with the worldwide closure of most insane asylums – an obviously premature action (Shorter 1997).

The medical success of the synthetic psychotropic drugs was a boon for the pharmaceutical industry, as well as the ruin of the psychoanalytic industry. It should also have killed the dualistic philosophies of mind, but in fact these are still going strong. Whereas in ancient Greece philosophy generated science, now it often blocks its advancement. Today, more than ever, we need to evaluate the worth of philosophies by their epistemic fruits (Bunge 2012).

Regrettably, all of the psychotropic drugs have nasty side effects, from headaches to skin rashes – reminders that human bodies are systems. To avoid or limit such unwanted effects, drug therapy requires the simultaneous use of psychotherapies such as cognitive behavioral therapy – which so far is little more than lending a sympathetic ear and dispensing reasonable advice. This fact should not be taken as evidence for the power of mind over matter, since words are material processes that, when impinging on a brain, may cause neural processes. Likewise placebos work because holding a belief is a cortical process that may act upon the immune system.

In recent years Big Pharma seems to have lost interest in improving psychotropic drugs, to the point that many important drug companies have closed down their research facilities. The main reason is the law of diminishing returns: it costs more and more to design and produce marginally better drugs, whereas offering doctors free "seminars" in Caribbean resorts renders them more susceptible to advertising.

Let us finally tackle the problem of "classifying" mental diseases, which had kept Emil Kraepelin awake. To begin with, one may classify a family of species only if each species is well defined. But it is notorious that most mental diseases are not well defined. In fact, they are usually characterized only by their syndromes, nearly all of which are shared by two or more disorders, such as paranoia and schizophrenia.

The problem of conceptualizing the mental disorders calls for the discovery of reliable markers or indicators. In other words, we need a function $\alpha: B \to \mathrm{D}$ that sets up a one-to-one correspondence between a set

B of brain states and a set *D* of mental disorders, such that, reading a marker *m* of the brain state *b*, we may infer the corresponding disease *d*.

In other words, we need a function α: $S \rightarrow D$ from symptoms (or their markers) to diseases, and a second function β: $D \rightarrow B$ from diseases to brain states, such that, for any s, $\alpha(s) = d$, and another, β, such that, for any d, $\beta(d) = b$. The composition of β with α will map symptoms diseases onto brain states:

$$\begin{tikzcd} S \arrow[r, "\alpha"] \arrow[dr, "\delta = \beta\bullet\alpha"'] & D \arrow[d, "\beta"] \\ & B \end{tikzcd}$$

Note that we would still need two additional levels of description, one in terms of *B*'s and another in terms of *S's*, because psychiatrists, unlike their patients, have no direct access to diseases, but have to go through markers. Presumably, mentally sick psychiatrists could manage with a single level. But how reliable would they be?

Phrenology would solve this problem if it were 100% right. For better or for worse, real brains are far more complex than Franz Joseph Gall imagined. Indeed, a whole battery of biomarkers is presumably needed to detect any mental disorder, since every one of these conditions involves a whole cluster of brain "areas," "centers," or circuits. Still, this fact does not disqualify the preceding formula for δ: it only requires us to reconceptualize *M* as a set of syndromes (or cluster of symptoms) instead of isolated symptoms, and *B* as a cluster of brain areas.

To take a simple example, the sight of a reptile will put the amygdala of a higher vertebrate on notice, only provided the subject has identified the reptile as a poisonous viper rather than an inoffensive grass snake. Thus, the person whose amygdala reacts to the sight of a reptile has a cerebral cortex whose cognitive part has converted the reptile percept into the viper concept.

In sum, we are confronted with the composition of three maps: one from external objects to sensa, another from percepts to concepts, and a third from concepts to fear feelings. In short, at least three brain regions are involved in the given process: the visual system (objects → percepts), the cognitive system (percepts → concepts), and the alarm system (concepts → fear feelings). A malfunction of any of the three systems would fail to translate the presence of the reptile into either fear or relief.

Let us finally jump from normal to abnormal mental processes, in particular the pathological ones. I submit that a worthwhile research project would be (a) to find batteries of objective markers or indicators of mental diseases; (b) to attribute every one of the latter to one or more brain subsystems, as in the case of the Deafness → Auditory system malfunction correspondence; and (c) to classify the species, that is, to group them into genera and families, and to inter-relate these groups in either a Linnaean (static) or a Darwinian (developmental-evolutionary) fashion.

Performing these jobs requires a much more detailed knowledge of the organ-function relation, as well as the use of the notion of the specific function of an organ – that is, the peculiar function or process that only the given organ can perform. For example, the specific function of the striate cortex is vision, as digestion is the specific function of the digestive system. Just as you cannot walk on your ears, you cannot think with your legs. Yet, many believed the journalists who reported that some Russian children could read printed words with their fingertips.

However, some brain systems are so vast, and our knowledge of them is so primitive, that they have been attributed multiple functions, hence malfunctions as well. For instance, the fusiform gyrus, located in the occipitotemporal lobe, has been blamed for prosopagnosia (inability to recognize faces), dyslexia, color processing, and more. This brain system has been analyzed into a number of subsystems, every one of them with a narrow specific function, such as reacting to tickling or single feature detection.

Contrary to functionalist or information-processing psychology, stuff is just as important as structure. Thus, Hilary Putnam's famous contention that our brains might as well be made of green cheese, is but a joke that would have made Cajal laugh uproariously more than a century ago. In fact, only neurons and glials qualify as the anatomical units of nervous tissue. Electronic devices such as chips and brain prostheses do not. Nor do computer programs play a legitimate role in neuroscience, which looks for natural laws, not artificial rules, when studying the brain. (True, there is some talk of "Hebb's rules," but this is just a linguistic slip.)

Besides, unlike machines, which have fixed structures, the central nervous systems of the higher vertebrates are plastic. In particular, they can gain or lose functions in response to environmental changes or under the action of neural prostheses such as cochlear implants to correct deafness. This alone suffices to weaken radical localizationism or the one site-one function hypothesis. Neural plasticity only qualifies this hypothesis, by adding that such localization is dynamic rather than static.

To conclude, suffice it to note that the present proposal is to transform psychiatric diagnosis from a rewrite of patients' self-reports – such as "I'm feeling low," "I'm hearing voices," and "They are out to get me" – to a description of the dysfunction of the pertinent cluster of brain subsystems. This shift might bring psychiatry in line with the rest of medicine, where diseases are identified with organ malfunctions, not with symptoms as described by patients. Symptoms are not explainers but what needs to be explained in terms of bodily processes.

For example, nephrology is the study and treatment of kidney diseases, and it covers not just hematuria (presence of blood in urine), which anyone can see, but also hypertension and other silent enemies. This is why the traditional name of this specialty, namely 'kidney medicine', was correct. So were 'cardiovascular medicine', 'blood medicine', and 'brain medicine'. The names 'cardiology', 'hematology', and 'neurology cum psychiatry' sound more learned, but they are not more correct. Go beyond disease symptoms and dig up the dysfunctions of the underlying organs!

7. TECHNOLOGY ≠ APPLIED SCIENCE

The popular press maintains the confusion of science with technology introduced by Francis Bacon when he demanded a "philosophy of works" to replace the "philosophy of words" he attributed to the schoolmen (Farrington 1964).

That confusion was updated by Auguste Comte, the founder of classical positivism, who coined the formula *Savoir pour prévoir, afin de pouvoir*. That confusion was also shared by the young Karl Marx in his famous Thesis XI, as well as by his coworker and friend Friedrich Engels, who mistook the utility criterion, *the proof of the pudding is in the eating*, for the truth criterion used by scientists, namely explanatory and predictive powers joined with compatibility with the bulk of the antecedent knowledge.

When the Second World War loomed over Europe, the eminent Marxist crystallographer John D. Bernal (1939) urged his countrymen to tackle civil defense from a scientific viewpoint. His advice was listened to only after German submarines sank a number of merchant ships carrying food and ordnance from the USA to the UK.

Patrick Blackett, well known for his work on cosmic-rays, understood that basic science is insufficient to tackle large-scale social problems such as those of defense. Accordingly he organized a team of scientists, mathematicians, engineers and management experts, to respond to the Nazi challenge. His team came up with a mathematical model of convoys large enough to justify aerial coverage but not so large as to tempt German submarines. This exercise in logistics marked the birth of operations research, the scientific phase of management science, one of the social technologies.

In the advanced countries, where roughly 10 percent of the world population resides, everybody is expected to be familiar with the *science-technology-industry-government* square. The emergence of this square, though, is still under debate, largely because it is a big problem, and the handling of big problems calls for the adoption of a systemic or multidisciplinary approach.

And this approach, adopted by Thucydides in the 5th century BCE, Ibn Khaldûn in the 14th century CE, and the *Annales* school of *histoire totale*

in the last century, is still a minority viewpoint. Let us see what light it can shed on the science-industry connection.

1. Applied science: the bridge between basic research and technology

In recent years some philosophers have tried to disentangle technology from science. In particular, we have learned that *applied* science must be interpolated between basic science and technology. For example, pharmacology is the link between biochemistry, a basic science, and the disciplines in charge of drug design and drug manufacture. In fact, pharmacologists select a tiny fraction of the millions of possible molecules, namely those that *may* be turned into drugs through the so-called *translation* process in the charge of the pharmacologists working in the so-called laboratories attached to drug companies. These people, or the automated machines they control, perform the myriad tests required to find out how those promising molecules act on the receptors sitting on cellular membranes (see Bunge 2013).

Schematically, the whole process looks like this:

$$\text{Biochemistry} \xrightarrow{\textit{Translation}} \text{Pharmacology} \xrightarrow{\textit{Manufacture}} \text{Industry} \xrightarrow{\textit{Sale}} \text{Market}$$

Technologists proper start working only at the last two phases: they design artifacts expected to produce drugs, while the chemical engineers working at pharma industrial plants (popularly called 'laboratories') design, perfect, repair or maintain the machinery that delivers the merchandise sold at pharmacies.

Let us now review two stories that, though apparently unrelated, are relevant to our problem: gravitational waves, and the cradle of the Industrial Revolution.

2. A first in big pure science: gravitational waves

The detection of gravitational waves in November 2015 should have unfused science from technology. Indeed, that sensational finding was a triumph of Einstein's basic or disinterested scientific research conducted exactly one century earlier. But the experimenters were greatly helped by the civil engineers who participated in the realization of the original design of the LIGO experimental installation, which engaged 1,000 researchers and involved two huge interferometers and two 4,000 meters-long vacuum

tunnels. (Only a century ago it was a feat to prevent leaks into a one-meter long vacuum tube.)

What motivated this recent successful search was not utility but sheer curiosity – just as Aristotle had taught. Indeed, the finding in question has no foreseeable practical applications, if only because the energy of the said waves is minute. Only the intervention of a few far-sighted bureaucrats made it possible to round up and organize a body of nearly 1000 specialists who spent 1,100 million US dollars working on a project that culminated a search that had yielded no results for nearly half a century. What sustained the faith of the members of the LIGO team was that Einstein's prediction was part of his complex if beautiful gravitation theory, additional predictions of which had been empirically confirmed since 1919. That was the year when the bending of starlight by the sun's gravitational field was confirmed by a team led by the astrophysicist Arthur Eddington. Since then, about 30 additional "effects" predicted by the same theory have been corroborated.

In other words, the gravitational waves hypothesis, far from being isolated, was firmly entrenched in one of the most important physical theories. In short, the LIGO finding was sought and accepted largely because it had been predicted by a successful theory. It killed two birds with one stone: the empiricist dogma that all scientific inquiries originate in observation, and the pragmatist confusion of science with technology.

3. Why Manchester rather than Paris

If technology sufficed to beget modern industry, and if the latter were just applied science, the Industrial Revolution (ca.1760-1820) would have started in Paris, the city of light, rather than in dark Manchester. In 1750 Paris, the second most populated European city, had 556.000 inhabitants, and was the seat of the largest and most progressive scientific and humanistic communities in the world. That is why Paris was the Mecca of all the best scientists and the most popular writers in the world. In contrast, Manchester, the cradle of the Industrial Revolution, had hardly 20.000 inhabitants, though this number grew tenfold in the course of one century, while the Paris population only doubled over the same period.

Recall this small sample of French scientists active during the Industrial Revolution: d'Alembert, Buffon, Condorcet, Lagrange, Laplace, and Lavoisier, to which we should add a bevy of foreign visitors, such as Leonhard Euler, Alexander von Humboldt, and Benjamin Franklin. The British scientific community of the same period was no less brilliant: suffice it to recall Babbage, Black, Cavendish, Davy, William Herschel,

Jenner, and Priestley. But the foreign scientists visited Paris, not London, let alone Oxford or Cambridge – which specialized in training clergymen, and rejected the admission applications of John Dalton because he was a Quaker – the first Mancunian to leave a deep track on basic science, for he founded atomic chemistry.

More to the point, none of the above-mentioned eminent scientists were interested in machines, so they made no significant contributions to the Industrial Revolution. The inventors of the steam engine, the spinning jenny, the steam regulator, and the automatic power loom, were self-taught engineers like Cartwright, Hargreaves, Newman, and Watt.

The most ingenious artifacts at that time were Vaucanson's automatic duck and Jacquard's programmable loom. But both inventions were fully exploited only two centuries later, by the computer and robotics industries. And except for Vaucanson, none of those inventors were much interested in basic science, and none of them expected riches from their inventions: they were driven by curiosity, imagination, and the joy of solving problems.

Moreover, none of those inventors qualified for membership in the Republic of Letters imagined earlier by Erasmus and Montaigne, for they felt at home in workshops, not in libraries or salons, and they preferred drawing diagrams of artifacts to writing tracts, novels, or letters. This fact alone falsifies the popular idealist thesis that the Industrial Revolution was but a late fruit of the new worldview crafted in the late Renaissance, the Scientific Revolution, and the Enlightenment.

The men who made the Industrial Revolution were far more interested in machines than in nature. In fact, they designed and built new industrial artifacts rather than telescopes or microscopes, and some of them joined or started commercial firms, not learned societies, let alone literary salons presided over by educated, elegant and rich ladies, like Mesdames Helvétius, d'Holbach, and de Staël, who lionized the writers, scientists, and philosophers of the day. "One" does not know today's inventors either – unless they happen to be phenomenally successful entrepreneurs like Bill Gates and Steven Jobs.

Even today, two centuries after the birth of science-based technology, Ahmadpoor and Jones (2017), after sifting through millions of patents and research papers, found that nearly 40% of patents do not originate in basic research. And, since the vast majority of patents are won for improvements rather than radical novelties, it may be conjectured that great imagination combined with patient trial and error predominates in technological advancement. Leonardo da Vinci, the greatest inventor in history, was neither an MIT graduate nor a Bill Gates employee.

Ayatollah Khomeini, the founder of the Islamic Republic of Iran, understood the difference between science and technology, which still escapes most people. In fact, in 1979 he told the fearless Italian journalist Oriana Fallaci that his faith embraced technology and its artifacts, such as fridges and cars, while emphatically rejecting basic science because it begat a worldview incompatible with religion.

4. Inputs and outputs of the Industrial Revolution

In early modern times great wealth came not from science-based technology but from large plantations worked by slaves, as well as from manufacturing plants using the new machines and financed by venture capitalists, in particular some of the merchants who had made huge fortunes in the slave trade. Thus, contrary to Marx's "law" of historical stages – slavery, serfdom, capitalism, and socialism – the slave trade was flourishing during the period we are examining, and contributed significantly to the birth of industrial capitalism (see Fogel & Enderman 1974, Beckert 2014). The new was feeding on the old.

In any case, contrary to Max Weber's claim, modern capitalism had little to do with Calvinism, but something to do with the mechanistic worldview inherent in the Scientific Revolution that started around 1500 P.E., and even more with slave labor and cotton, the most versatile raw material and the new global commmodity, superior to gold, silver, and spices.

Slavery was not abolished in the US because slave work had become unprofitable, as some Marxists thought, but only after the long and bloody War of Secession. Thus, abolition was a political event, not an economic one, and it was helped as much by the pious Quakers as by the daring French Enlightenment philosophers.

Far from being generated only by technology, the industrial capitalism born in Manchester, Liverpool and similar English towns had the inputs shown in the following diagram:

$$\left.\begin{array}{l}\text{NEW TECHNOLOGY}\\ \text{NEW RAW MATERIALS}\\ \\ \text{NEW LABOR \& CAPITAL}\end{array}\right\}\quad \begin{array}{l}\text{NEW MILLS} \rightarrow \text{NEW PRODUCTS} \rightarrow\\ \text{NEW MARKETS}\end{array}$$

Let us comment briefly on both the inputs and the outputs of this system. The new technology made only a very small use of the new science born three centuries earlier, as can be seen from the biographies of the inventors of the new machines, in particular the spinning jenny and the automatic loom. Indeed, none of them had gotten the higher education required to understand the new science: most of them were craftsmen rather than scientists or engineers, and one of them was a doctor in divinity.

In contrast, coal, cotton, labor and credit were abundant and therefore cheap at the time. In fact, as David Ricardo had noted, the salaries earned by the workers in the English cotton mills for 14 hours a day just kept them from starving – about 20 pennies, or 10 kilograms of bread per day in 1740. (At the present time, in the US, labor counts for less than one-tenth of the cost of an ordinary merchandise.) Just as important was that rural employment was even worse paid and seasonal, whereas industrial jobs were basically permanent – barring raw material scarcities, as happened with cotton during the American Civil War.

Capital too was plenty and cheap in Britain at the time of the Industrial Revolution, for the slave trade was both intensive and extremely profitable. The main slave route was England-Gulf of Guinea-Caribbean or Southern USA-Britain. Basically, slaves were traded for cotton, sugar, coffee, and tobacco – all four cultivated at low cost in American and Caribbean plantations worked by four million slaves. Unlike aristocrats, who invested mainly in land or in low-yield bonds (typically, 2% Consols), slave traders invested mainly in the new industries. Consequently, the English industrialists did not need to borrow from banks or money-lenders. The French industrialists had no access to that kind of capital because Haiti, their only colony with slave labor, was far smaller than India and did not supply cheap raw materials. Besides, the French inventors' ingenuity was held back by the prudence of the French money makers and wealth custodians, such as the notaries.

The main product of the cotton mills was calico, a cheap cotton cloth suitable for dresses, saris, pants, blouses, shirts, tunics, kurtas, loincloths, underwear, swaddles, sails, curtains, bedding, shrouds, and more. Unlike the woolens, linen and leathers worn by the poor, and the silk brocades manufactured in Lyon for the wealthy, the English cotton cloth was accessible to millions of people around the world. That was the secret of the success of the Industrial Revolution: mass consumption through mass production, and mass production through slave labor in the fields, jointly with new machinery in the new mills.

There was, of course, the competition of the cotton cloth that the natives produced with the primitive manual looms common in Indian houselholds. But the Brits knew how to deal with them: they incapacitated the Bengali weavers by chopping off their thumbs. Surely this practice was inconsistent with the high-sounding free-trade rhetoric of the English politicians and their moral philosophers. But someone had to pay for progress. And the Brits working in India made sure that neither the industralists nor the merchants paid for the colonial bounty. Indeed, the burden of British colonialism fell on the Indian workers and the taxpayers, both in Britain and in India, who supported the half-a- million-strong British Indian Army composed of loyal Sepoys led by men endowed with an "inborn capacity for leadership."

Last, but not least, were the ecological disasters caused by cotton cultivation with intensive irrigation. A recent victim of this practice is the salinization of the soil surrounding the Aral Sea in Uzbekistan following decades of intensive cotton cultivation. A similar soil salinization caused by irrigation had transformed fertile land devoted to cereal cultivation into arid expanses and the corresponding decay of the Sumerian and Maya civilizations.

It took people several millennia to learn that nature does not obey the commandment "Thou shalt maximize thy profits," whence technology should be regulated to contain the associated social and ecological costs (Agassi 1985). But all new regulations on business will be resisted in the name of freedom and progress. It is hard to learn that there can be too much of a good thing.

Conclusions

We have defended the theses that technologists, applied scientists and basic scientists employ the same method but pursue very different goals: whereas technologists seek utility, basic scientists try to find new truths for their own sake, and applied scientists focus on truths of promising practical utility. Still, the individuals in all three camps are primarily motivated by curiosity, and they all pursue truths of fact.

Further, advanced experimental research in Big Science makes intensive use of high-tech, as in large-scale automatic drug trials, neutrino detection, and black hole research. To indulge in Bible talk, let both Mary and Martha do their jobs on the Lord's vineyard. In other words, we need both brain and brawn. So, let us neither confuse them nor regard one of them as being superior to the other. They need one another, and *Homo sapiens* needs them both to avoid becoming *Homo stultus*.

However, we should try to keep making progress without exploiting anyone. We no longer live in 1845, when the great Heinrich Heine empathized with the Silesian hand-weavers, victims of the automatic power loom, and prophesied *Altdeutschland, wir weben dein Leichentuch* ("Old Germany, we weave your shroud".) We have made much social progress since building the welfare state in much of the so-called West. But it is high time to complete the task started two centuries ago by the social reformers who sought social justice – the balancing of duties with rights, and the control of technological progress to avoid its evil effects – massive labor "redundancy," ever more destructive wars, environmental degradation, and dumbing entertainment. We should be able to paraphrase Heine, saying *Neuzeit, wir weben deine Windel.* ("Modern times, we weave your nappies".)

8. Liberties and Democracies: Authentic and Bogus

Politics is about the distribution of public tasks and rewards, or burdens and goods – or social powers. One may distinguish three kinds of power: economic, political, and cultural. For example, at the height of his career, Silvio Berlusconi was the wealthiest Italian, wielded the strongest political power, controlled the most powerful politicians, and owned the most influential and profitable TV stations, newspapers, publishing houses, and even a soccer club, whereas his domestic servants and whores were at the bottom of the social ladder. And, of course, he called Polo della Libertà his own party, which worked as his private firm.

Presumably, all the primitive societies were egalitarian. For example, the American Indians of the NW coast divided amongst themselves everything they fished or hunted. They also shared their surplus in the annual *potlacht*, an opulent feast that served to equalize riches and gain prestige: the more generous the host, the more honored he was. Social stratification is coeval with the earliest civilizations, which emerged some five millennia ago in the Near East and China.

Presumably, at the beginning there were only two social classes: the victorious warriors and their prisoners, who were forced to perform all the menial tasks. In ancient Egypt there were the pharaoh and his family, his or her courtiers, the priests, the craftsmen and traders, the farmers, and the scribes and artists. Likewise, in ancient Greece there were landowners, farmers, craftsmen, sailors, traders, slaves, and foreigners. Only those who owned land, shops or slaves could be citizens, attend games and schools, and vote as well as exercise the magistracy.

Throughout antiquity, both East and West, the political and cultural (in particular ecclesiastical) powers were in the hands of the Few, who did no manual work. The Many, who earned their living working with their hands in fields, workshops, mines, shipyards or homes, held neither cultural nor political power. The 317 BPE census found that in Athens there were about 100 slaves per free man, but most households had only three or four slaves. And, regardless of the way they were treated, most citizens regarded slaves as pieces of property without reasoning ability or rights. Paul the Apostle, the founder of Christianity, exhorted them to fear and

tremble in the presence of their owners. Only the Stoics and Plato – who owned five slaves and opposed democracy – attributed them rationality.

All the ancient authors, from Herodotus onwards, said it clearly: the ancient Greek democracy was government by the *demos* or people – the regime where each citizen could cast one vote – but they failed to note that only the free men, who constitued a tiny minority, could vote. Herodotus did not tell us whether democracy begat happiness, but he explained that, once the Athenians got rid of tyrants, they became by far the best soldiers of all because, instead of obeying a master, they fought for themselves – the same argument used two millennia later by the socialists for economic self-determination.

True, in Athens at the time of Pericles democracy was restricted to the free men, who constituted about one-fifth to one-tenth of the population. In the advanced Western nations, until a couple of centuries ago, even during the French Revolution, voting was limited to property-owning males. Still, that was the earliest governance through political equality. Political progress since 1789 has consisted in the gradual expansion of political democracy, whereas its restrictions, whether on the right or on the left, have been politically regressive.

At the same time, the documents that exalted the virtues of political equality papered over the underlying economic inequalities. These were denounced only by a handful of socialists and anarchists, as well as by the eloquent *Communist Manifesto* of 1848, which became widely known and influential only one generation later.

At the present time, only the orthodox economists ignore Jean-Jacques Rousseau's seminal thesis, that inequality is the root of all social evils. But the earliest numerical measure of income inequality, the Gini index, was invented only in 1912. Since 1980 it has been replaced by the UN human development index, a composite statistic of life expectancy, education, and per capita income indicators. This index should be completed with the political component of development, namely the degree of voluntary political participation and science-based (rather than populist) governance (Bunge 2009).

The democratic/undemocratic split is too coarse to do justice to all the types of regime that have been tried or imagined over the past two centuries. In particular, the division of countries into those that allow free elections and those that do not, is misleading both because votes can be bought and elections rigged, and because casting a ballot once every four years is the least a good citizen can do for his country: real democracy involves the active participation of the citizenry in town hall meetings, political parties, NGOs, and rallies all year round. Sham elections, like

those that kept dictatorships in power for several decades, should not count, because they did not contribute to building authentic democracies, that is, societies of partners.

Tolerance of mass protests would seem to be a reliable test and indicator of democracy, since political leaders are sensitive to public opinion, particularly when protesters display worthiness, unity, numbers, and commitment (Tilly, 2003). The question, though, is whether a protest movement can generate a new political party capable of altering the political status quo. Let us briefly recall two recent protest movements that surprised everyone: the Greek Syriz*a* party in 2004, and the Spanish *Podemos* in 2014. Both parties won elections, and Syriza formed a short-lived government that was forced to impose the additional austerity measures demanded by the European financial cartel. In 2011 the no less multitudinous and vocal *Occupy Wall Street* movement in New York City denounced the increasing economic inequality, as well as the corrupting power of big money. But its presidential candidate, Senator Bernie Sanders, was silenced by his own party's bosses, and Americans elected a plutocrat. In short, none of the protest movements that occurred in the USA after the African-American Civil Rights Movement in the 1960s attained its goals. Apparently, not all peoples are ready for real democracy or people power.

In the end, neither of the above-mentioned protest movements accomplished anything beyond raising hell for a while. Although they fulfilled Tilly's four conditions, they failed a fifth, namely subduing financial power. In short, the status quo begets protests that a democratic regime will tolerate but not necessarily listen to.

Integral democracy is yet to be tried in modern times, but I have included it because it helps identify the flaws of its alternatives. For example, some politicians swear their love of democracy even while riding on top of the only empire there is, and others call themselves socialists even while presiding over regimes where wealth is not being owned and managed cooperatively. See the following diagram (Bunge 2018).

Integral Democracy	*Social Democracy*	*Liberal Democracy*	*Managed Democracy*	*State Socialism*
Coops, NGOs, Parties	Parties, NGOs	Parties	The 1% Party	C.P.
\ ↓ /	\ ↓ /	↓	↓	
Servant state	Servant state	Parasitic state	Minimal state	Total state
|	|	|	|	|
Superb s.s. Peaceful	Superb s.s. Peaceful	Poor s.s. Hawkish	Minimal s.s. Warring	Mediocre s.s. Peaceful

Fig. 10.1 The main ideal regime-types; s.s. = social services.

The expression ‘managed democracy’, coined by Sheldon Wolin (2008), is a synonym of neoliberalism, neoconservatism, oligarchy, or plutocracy – a regime where the state is ultimately run by the big corporations, whose beneficiaries comprise less than 1% of the population. State or authoritarian socialism was the regime that used to rule the late Soviet Union and its satellites. Although this regime attained a sort of economic democracy, wealth was neither owned nor managed by its creators, the polity obeyed the party, and the culture too was managed by it, which tolerated no revisions of its frozen ideology. Still, this undemocratic regime commanded the loyalty of most of its citizenry, as shown by their sacrifices in the Second World War, during which their nation was invaded for the ninth time since its birth one millennium earlier – in Kiev, modern Ukraine’s capital.

However, let us not be distracted by historical contingencies. The key term in the above figure is *democracy,* which originally meant rule by the *demos* or people. What I call *integral democracy* is the broadest or most inclusive kind of democracy: the one whose slogan is “Those who *work* the land are entitled to rule it,” instead of “Those who *own* the land are entitled to rule it.”

Since ‘the land’ is here understood as the total wealth, or the system of means of production, exchange, and credit, and since what is being produced or consumed is anything worthy, from bread and hammer to poem and theorem, we may as well spell out the preceding slogan to read *For every X, those who make or use good X are entitled, indeed obligated, to manage X.* An equivalent formula is obtained using the broad concept of power – economic, cultural, or political – namely *Everyone has the right to access all the sources of power, as well as the duty to preserve and if possible also to enrich them.*

In light of the preceding, the expression ‘authoritarian socialism’ sounds like an oxymoron, for it involves concentreating power in the hands of the few, whereas ‘democratic socialism’ reads as a pleonasm. In short: *To democratize is to socialize*, that is, to include or share. Notice that we have included burdens along with rights. In other words, we have tacitly used the concept of social justice as the *equipoise of rights and duties*.

Notice that the preceding sentence is not only an ideological principle but also a moral one. Indeed, anyone who claims to be entitled to *X*, or have a right to *X*, should be told: *All right, you’ll get X, but only if you pay off for X with a good or deed Y worth X.* This reply ought to satisfy all those who present capitalism as the fairest of all social regimes but overlook surplus value and the expansiveness of capitalism. President

Barack Obama's reference to "market-based democracy" exemplifies that forgetfulness. Abraham Lincoln might have reminded Mr. Obama that authentic democracy is *people*-based – but the very notion of *demos* is alien to neoliberalism. And the point of managed democracy, aka neoliberalism, is to replace the people with the privileged minority that manipulates the market – the standard euphemism for unregulated capitalism.

The intimate relation between government and corporation lends itself to corruption in the form of bribes paid to civil servants in exchange for services. NGO Transparency International keeps track of perceived corruption in all countries, from the cleanest, Denmark, to the dirtiest, Somalia, which occupies the 167th position. The USA currently occupies the 16th position. But this ranking omits lobbying, which in the USA is institutionalized. Indeed, the US government keeps an official registry of the 4,500 professional lobbysts in Washington, D.C., representing big corporations with the explicit aim of influencing legislators and even drafting bills for them. Then, there is the free-lance and undocumented work of retired generals, some of whom build bridges between big firms like Halliburton and the armed forces. Not in vain Samuel Huntington, who used to be the most influential American politologist, declared that bribes are "the grease that lubricates the wheels of business."

Now, a word about *regime change* – an expression popularized by George W. Bush and his ministers in their imperial attempt to impose by force their personal version of democracy on the rest of the world. Such an attempt is of course undemocratic, for it comes from above and with military violence, whereas democratization proper is a bottom-up process – like the French revolution of 1789, the central-European ones of 1848, the Russian ones of February and October 1917, the Chinese of 1949, the Cuban of 1959, and the central European anti-Communist revolts in the late 1980s. That many of these popular movements ended up in undemocratic regimes is beside the point. The ignition point was the toppling of dictatorships that had imposed the exploitation by parasitic classes, and that most of those revolts caused the hostile intervention of foreign powers.

The ideal regime change is the one carried out peacefully by the many for the many. Regrettably, such an ideal political transition has seldom occurred, because the few have refused to give up their privileges without a fight. One of the very few exceptions was the dismantling of the Apartheid regime in South Africa thanks to the wisdom of the heroic Nelson Mandela and the crafty but realistic Afrikaner president Frederik de Klerk. But even this negotiated regime change came only after several

decades of revolutionary fighting, the murder of many freedom fighters, and Mandela's harsh prison during 27 years.

Most attempts to effect progressive regime changes, starting with Spartacus' in 73 BPE, were suppressed violently by the ruling clique. In some cases, such as those of the Philippines, Cuba, Puerto Rico, and later on Vietnam as well, such repressions unintentionally reinforced the national liberation movements and gave the US expansionists a pretext to intervene militarily and assume the role of the former colonial powers (Stone & Kuznick 2012, Kinzer 2017).

A remarkable exception was that of the East-European Communist leaderships, which in 1989 resigned without firing a shot – and let their countries fall into either anarchy or the laps of robbers improvised as businessmen. The purely political reforms announced the year before by Mikhail Gorbachov failed to mobilize the people, and only caused confusion and dispiritedness, for they involved a rejection of the past seven decades but not the construction of a better social order. In particular, they did not involve the transformation of the state owned enterprises into cooperatives owned and managed by their workers.

However, the said reforms relaxed international tensions and marked the end of the support of the sagging economies of the friends in the so-called socialist camp, thanks to which they had been living better than in the Soviet Union. Central planning was suddenly abandoned, and a mixed economy was promised, whereby private initiative would be encouraged. But the orphan farms and factories, used to obeying orders from far away, were left adrift, to the point that the armed forces had to be sent to collect the cereal. The central political power fell into the hands of Boris Yeltsin, a courageous and charismatic drunkard who allowed a bunch of improvised capitalists, the oligarchs, to seize and loot the most profitable state enterprises and sell them for a song (Fontana 2011: 814 ff).

The Soviet dictatorship, which in the course of a few decades transformed an agrarian society into the nation that destroyed the most powerful army in history, self-destroyed in the course of few years for want of an authentically socialist ideology capable of mobilizing the masses. Marx, Engels and Lenin may be blamed for the failure of Soviet socialism, for believing in historical fatalism, as well as for admiring Robespierre's state terrorism and despising cooperativism, which combines the socialization of property with its democratic management. In conclusion, socialism has remained backward, and to update it, its philosophical sources should be renewed.

In short, neither the winners nor the losers of the Cold War offered optimistic prospects. The winners discredited democracy by subjecting

politics to the big corporations, and the losers discredited socialism by combining it with tyranny. What is to be done? We should never tire of repeating Abraham Lincoln's idea of democracy as "the rule of the people, by the people, for the people."

Rule of what? Obviously, what is meant is the biological, economic, political, and cultural systems that make up every human society (Bunge 1979). The idea is to *expand democracy* to cover all the aspects of life, that is, to enrich genuine political democracy (voluntary participation in public affairs plus one human-one vote elections) with biological democracy (gender equivalence), economic democracy (equitable distribution of benefits and burdens), and cultural democracy (equal access to all the cultural goods, from languages to philosophy).

Let us read Louis Blanc (1847) to learn why shared property is both economically and morally superior to private property. Incidentally, Engels (1970) was wrong in putting Henri de Saint-Simon and Robert Owen in the same box of utopian socialism as Charles Fourier. Indeed, Saint-Simon was an early technocrat since he wrote on the rationalization of industry, not its socialization. And Owen put cooperativist socialism into practice in the factories he organized in the UK and the USA. As for Fourier's socialism, it was severely distorted by his radical statism, which excluded self-government, for it distributed tasks and burdens *a priori* and once and for all, regardless of the individuals' abilities and wishes. (The clearest and shortest characterization of statism is Mussolini's: "Everything in the state, nothing out of the state, nobody against the state." Stalin is likely to have thought the same, though he misnamed it 'socialism'.)

Finally, let us disclose the philosophy behind neoliberalism, the most popular if controversial version of democratic capitalism. Its ontology is *individualistic* rather than either holistic or systemic, for it holds that the market is a collection (not a system) of free and rational individuals intent on maximizing their expected utilities; its epistemology is flawed, in that it identifies society with market, as well as *holistic*, for it holds that "the market knows best," as Hayek once put it; and its ethics is *utilitarian,* in that it attributes all individuals the intention of extracting the maximum profit from every action.

In other words, the ontology of raw capitalism is wrong, for it ignores the bonds that tie individuals into systems of various kinds, from family and club to business firm and state agency; its epistemology is false because markets, having no brains, cannot know anything, hence they have neither memory nor learning nor planning abilities; and its ethics is immoral because, as Keynes put it, the psychological motivation of the corporation CEO is greed – hardly a noble and humanistic incentive. In

short, the entire philosophy of capitalism is wrong: its metaphysics is flawed because it denies the very existence of supraindividual entities such as firms and markets; its epistemology is flawed because it asserts that the market, which is brainless, knows best; and it is ethically wrong because it fosters selfishness and condones military aggression in the pursuit of new natural resources and new markets. The fearsome cat has been sighted, but who is willing to bell it, and where are the mice capable of building a fair society of partners from the bottom up?

9. AMATEURS AND PROFESSIONALS

Amateurs are people who dabble at something they love. Professionals are persons disciplined enough to learn what it takes to master a field, and practice it competently whether they love it or not. The sociological counterpart of this difference is the insider/outsider dichotomy. The insider is an active member of a formal organization, such as a learned society, whose members are engaged in research projects, which they share with colleagues in laboratories, meetings and journals. The outsider, by contrast, may wish to gain celebrity but not one shared with coworkers or disciples.

The hard road from hobby to profession may be diagrammed as follows.

CURIOSITY→ AMATEUR
> APPRENTICESHIP → PROFESSIONALISM
ABILITY

Not all amateurs can study what they love. In some countries, lawyers are frustrated social science fans, engineers are failed mathematicians or physicists, and clinical psychologists are people who like to dispense advice. Possibly, most art and science fans are dabblers. They love a subject they hardly understand, which is like making love online. Their curiosity and enthusiasm are genuine, but not enough to make the effort of learning their favorite subject in detail, much less in depth. They neck or even rape their subject instead of making love to it.

Thus, the amateur historian or philosopher of art may read a whole library of books on artworks, but won't be able to take paper and pencil, and draw a flower or a face; and the typical philosopher of science may write papers about "$E = mc^2$" but won't be able to tell us what properties the symbols represent, or even what it is about. Thus, a famous philosopher of science was annoyed to read in a book of mine that the above equation only holds for massive entities, as it is a theorem in relativistic mechanics, which refers to particles and bodies, not to fields. The same scholar also informed me in a professorial tone that Einstein's general relativity is a generalization of special relativity to accelerated motions: he had not heard that it is a theory of gravitation.

The cause of such deficiencies is obvious: amateurs are self-taught, that is, they do not undergo a rigorous apprenticeship guided by mentors. Consequently, they do and read what they want, not what it takes to master a subject. Typically, the amateur mathematician, physicist or astronomer will skip the mathematical formulas, and the amateur social theorist will expatiate on any social issues wihout leaving his study. And most philosophers, sociologists and historians of science are not equipped to read original scientific papers: they only read popularizations that describe results of scientific research, not the projects yielding such results. But such projects happen to be the units of live science or *scientia ferenda* by contrast to the *scientia lata* preserved in textbooks (Bunge 2017b).

Needless to say, professionalism does not guarantee competence. All fields of knowledge host some incompetents and even impostors who learn how to publish garbage or plagiarisms in respected journals. There are several ways to fool gatekeepers. One of them is to say the obvious in technical jargon. A second way is to plot some variable against another that cannot possibly be causally related to the former – for example, divorce rate against the price of crude oil. Examples of both strategies fill the pages of the hilarious *Journal of Irreproducible Results*, which has been published since 1955.

A third, far harder technique to win one's academic stripes without originality is to teach arcane subjects that attract nobody who is up to date in a living discipline. A safe bet is axiomatic set theory, for it was born in 1909, is self-contained and devilishly complicated, yet it can be taught from standard textbooks, so that it will not be coveted by any creative mathematicians. Further subjects in the foundations of mathematics, such as model theory, may also be used to impress the layperson. For example, mere mention of the Löwenheim-Skolem theorem will intimidate any philosophy student, even though it has never helped tackle any philosophical problems, or even ordinary mathematical problems, because it is a very special result. (The theorem in question states that every abstract theory with models, such as group theory, has also a denumerable model.)

This is how Wittgenstein fooled Russell for a while: by talking about arcane subjects even though, as Paul Bernays (1976) pointed out, Wittgenstein's mathematical knowledge was no better than a housewife's. Much the same may be said of the rest of Wittgenstein's legacy: no special knowledge is needed to understand his *Tractatus* or his *Logical Investigations*. This is why Wittgenstein is the amateur philosopher's philosopher.

However, most dilettanti wishing to pass for professionals will choose to pass through a wider door, such as Jacques Lacan's brand of psychoanalysis,

which he himself characterized as "the art of chattering" [*bavardage*]. If the amateur starts in virgin territory, he has it made. Think of the pre-Socratics, the first moderns, or the 19th century naturalist-explorers like Charles Darwin and his gigantic Patagonian fossils, or Alexander von Humboldt and his rich American ecosystems. Reading about their findings is interesting, while discovering them must have been exhilarating. Likewise, Leeuwenhoek's discovery of microbes was sensational, and the popular accounts of his scientific study two centuries later rightly placed "microbe hunters" at the top of the celebrity pole.

The advantages of dabblers over professionals are that they tend to choose "lite" subjects and most of them write better than their professional counterparts. In fact, they are mostly journalists or literary critics who have never even tried to write for professional journals. They also flatter those whose only ability is to handle words. Consequently they have many more readers and a stronger impact on culture than the experts, who write mostly for colleagues.

For example, Herbert Spencer's books on evolution sold far better than Darwin's, although his own version of evolution was a distortion of Darwin's original work. Likewise, any of the current works on popular cognitive science, such as those of Steven Pinker, are far better known than Donald Hebb's 1949 trailblazer.

There have been a few exceptions to the generalization that popularization involves distortion. Some of the most popular science writings have been Galileo's *Dialogues*, Euler's *Letters to a German Princess*, Faraday's *Life of a Candle*, Einstein & Infeld's *Evolution of Physics*, and Steve Jay Gould's columns in the *Natural History* magazine.

1. Professional amateurs

Rousseau le Douanier was perhaps the only amateur painter to attain the highest professional level, whereas the paintings of Adolf Hitler and Winston Churchill have remained in obscurity. In academia, professional amateurs are individuals who believe, or try to persuade others, that they are entitled to pontificate on subjects that they themselves do not understand because they have never studied them seriously. Thus, many great artists complain that art dealers, rather than fellow artists, decide who are genuine artists, just because they have the power to exhibit and sell their work, or refuse to do it. By contrast, most amateur philosophers of science should be glad that most gatekeepers of their field know as little science as themselves, so they will accept their submissions and reject those of experts.

Let us recall just three cases in this category: the revival of Berkeley's subjective idealism, the structuralist school in the foundations of physics, and the post-Mertonian sociology and history of science. Berkeley's subjective idealism survives in the claim that quantum physics proves that facts are the creations of their observers – in other words, that physical entities have no properties other than those that their observers attribute to them. To confute this antropocentric view there is no need to resort to microphysics. Just think of the aurora borealis or Northern Lights, the most spectacular natural show on Earth. This huge riot of colors is the effect of showers of cosmic rays falling on the atoms of atmospheric gases and exciting them, so that subsequently they emit multicolored radiations. Presumably, the Northern Lights started eons before the first humans emerged, and the few people privileged to observe this spectacle over the past millennia have played no role in producing them in the laboratory.

We alter things when experimenting on them, not when conducting passive observations. For example, spectroscopists copy the aurora borealis on a small scale when ionizing a cloud of gases to the point that it emits radiations whose wavelengths can be measured. However, the whole operation, from ionization to measurement, can be automated: the physicist's role is limited to designing the experiment; he works at arm's length to guarantee objectivity. The knowing subject is the object of psychology and epistemology, not of physics.

Further, none of the physical theories accounting for either observations or experiments include variables representing human traits: all their variables, in particular atomic energy level and radiation frequency, are strictly physical. When eminent physicists like Niels Bohr and Werner Heisenberg asserted that quantum physics puts the observer in command of facts, they offered no arguments for such contraband of Berkeley's central thesis, that "To be is to perceive or to be perceived." In physics to be is to become, without any assistance other than auxiliary physical processes such as putting in place the different pieces of an apparatus, so that it may do its thing without further human intervention.

Half a century ago the structuralist school, headed by Patrick Suppes, Joseph Sneed, and Wolfgang Stegmüller, attracted a number of philosophers who attempted to axiomatize classical point mechanics, a subject that Newton had nearly completed in his *Principia Mathematica* (1687). The initial paper, by McKinsey et al. (1953), employed some of the results obtained half a century earlier by the Peano school of modern logic, in particular the proof that the concept of mass was primitive, that is, not definable – contrary to Mach's false claim that the mass concept could be defined in terms of acceleration.

Regretfully the authors left out the concept of reference frame, so that they tacitly condoned that of absolute motion. Moreover, the said school never went beyond point mechanics and thermostatics, so that they missed all the new concepts that had been forged during the previous century, in particular those of extensive body, heat transfer, force field, and quantum-mechanical object.

In short, the structuralists contributed nothing to the advancement of knowledge. Nor could they have done it because none of them had studied physics. Their ignorance of physics was such, that one of them once suggested replacing ordinary logic with three-valued logic as the price for admitting ill-formed formulas such as "Length of this string = 100," which would earn any high school student a resounding F. They ignored the concepts of unit (such as cm^3 and pint for volume) and dimension (such as LT^{-1} for velocity and ML^{-3} for specific weight), which Suppes confused with that of size. (For a theory of dimensions and units, see Bunge 1971b.)

The worse omission incurred by the structuralists was the concept of physical meaning – which is why those philosophers called themselves 'structuralists'. It is well known that the theories about real things, from particles and photons to brains and social systems, consist of mathematical formalisms whose basic concepts are assigned factual meanings – whence the need for what may be called *dual axiomatics* (see Bunge 1967c, 2017).

Our third example is Richard Dawkins, an amateur geneticist who became a celebrity overnight. His book *The Selfish Gene* (1976) was an instant bestseller because it proclaimed the astounding thesis that genome is destiny. In fact, he claimed that the very existence of organisms is "paradoxical," since they would be just the funnels through which genes go from one generation (of organisms!) to the next. Thus neither birth nor death would be involved in evolution.

Any biologist will admit that radical geneticism is utterly false. Firstly, DNA molecules do not duplicate themselves, but need the assistance of enzymes. An organism's genome is only one of the constituents of a system that includes enzymes. The organism synthesizes the enzymes but it must get the proteins from its immediate environment. This is why an organism dies when cut off from its environment. And this is why attention has recently been shifted from the genome to the proteome.

Secondly, natural selection, the main evolution mechanism, acts on the organism as a whole, since this is what is being selected. Thirdly, in recent years epigenetics has shown that, far from being insensitive to its environment, the latter may act upon the genome by methylating some genes – a change that may be inheritable. In short, Dawkins's selfish gene is just a mythical entity – which is why it became instantly incorporated

into the pseudoscientific worldview propagated by the popular media. In short, Dawkins is an eloquent debunker of biological creationism with an interesting if wrong story that implies the irrelevance of the science of living beings.

Let us finally jump to a far better known case of dilettantism: that of Thomas S. Kuhn. His 1962 book *The Structure of Scientific Revolutions* had an instant success, partly because its title contained the words *structure* and *revolution*, which figured prominently in the rhetoric of the time. The idea that once in a while science undergoes transformations so radical that they deserve being called 'revolutionary' was popularized by Auguste Comte in 1844. One century later it became one of the foci of the essayist Gaston Bachelard, who wrote on the psychoanalysis of fire, and in 1938 introduced the expression '*rupture épistemologique*'.

Kuhn imputed a *structure* to such discontinuities. This was wrong, since the standard meaning of that concept is "set of relations among the components of a complex object," something that Kuhn did not intend. But the word sounded nice and had become fashionable after the popularization of Ferdinand de Saussure's structuralist linguistics (1916). Claude Lévi-Strauss's structuralist anthropology (1938), and Louis Althusser's musings about Marx, Freud, and Lacan were similar.

Kuhn's doctoral dissertation, written under John Van Vleck's supervision, dealt with a problem in solid state physics, a piece of research belonging to "normal science," to use his own term. No sooner did Kuhn get his doctorate, than he jumped to the history of physics and astronomy. He lost no time studying any of the consecrated authors in this field, and spent no time in dusty archives. On the other hand, Kuhn was one of the few to read Ludwik Fleck, an epidemiologist turned sociologist of science, who in 1936 had claimed that diseases are created by physicians – but saved the lives of fellow Nazi death camp fellows by heading the team of inmates charged with killing typhus-carrying lice. Who said that all honest people have the courage of their own convictions?

Kuhn also listened to his friend Paul Feyerabend, another academic shipwreck in search of instant fame – which he achieved by declaring that there is no such thing as objective truth: that everything depends on one's biases, so that "anything goes." Before achieving celebrity, Kuhn did not interact with any of the leaders of the historical, sociological or philosophical communities, for he did not attend any of the important meetings in those disciplines. Nor did he publish specialized papers in the learned journals: he only published a couple of potboilers using second-hand scholarship. Kuhn was a dark horse whose *Structure* won him instant

celebrity, partly because the student rebels of the time took him for one of theirs, while actually he was politically conservative.

What can an unknown person do to achieve instant fame? He may follow the example of the Dadaists, Futurists, Conceptualists and Absurdists in letters, or that of radical surrealists or constructivists in the plastic arts. There is no need to learn to write or draw before publishing or exhibiting one's poems or artworks: one rejects tradition, improvises, renames familiar ideas or things, and takes the public by surprise, as Marcel Duchamp did when he exhibited a urinal as an artwork titled "The fountain."

This is how Kuhn proceeded: he called 'paradigm' what had been known as standard background knowledge, and – following Feyerabend – renamed 'incommensurable' what had been known as incomparable. None of the established science students were impressed, but thousands of fellow amateurs were taken in. For example, they cheered when Kuhn and Feyerabend claimed that the relativistic concept of mass was incommensurable with is classical counterpart: they did not realize either that the difference between the two is that the later concept involves that of reference frame, and that careful experiments on electronic beams in a vacuum had vindicated Einstein's famous formula for the relative mass. This formula belongs in Einstein's special relativity theory, the theoretical mechanics that grew from the metatheoretical requirement that the formulas of mechanics should be invariant under the same Lorentz transformations that left Maxwell's electrodynamics unchanged.

Relativistic mechanics approaches classical mechanics for slow motions, that is, when v/c is much smaller than 1. This requirement was later generalized into the so-called *correspondence principle*, stated independently by both Einstein and Bohr. So much for the incommensurability thesis concocted to save the dogma that scientific revolutions are total rather than partial. The serious historians of science know that scientific changes, just like the biological and social ones, are continuous in some respects and discontinuous in others.

Kuhn should not be faulted for failing to subject scientific concepts to a rigorous semantic analysis, for at that time only Frege and Russell took semantics seriously. But Kuhn can certainly be said of have been a failed physicist, since he did not publish any original papers after completing his doctoral dissertation.

Nor was it his fault that he was often presented as a sociologist of science, for he never claimed to be one: in fact, he never studied any scientific communities. Like his idealistic precursors, Kuhn studied ideas in themselves. Moreover, he regarded himself as both a historian and a philosopher of science. We should accept this self-portrait, with the

proviso that he was often confused or wrong. In particular, as Margaret Masterman (1970) showed, Kuhn lumped 21 different concepts under the term 'paradigm', and he was plain wrong in replacing the concept of objective truth (or adequacy of idea to its referent) with the constructivism-relativism dogma. However, unlike Feyerabend, who ended up by denouncing science, Kuhn had become a serious thinker by the time he published *The Essential Tension* (1977). Yet he kept confusing maps with the territories they represented, as shown by his reply to a journalist who asked him whether he thought that the world changed every time a new world view was proposed: "Of course!"

Kuhn's work is central to the counter-culture movement, but it is not highly valued elsewhere. By contrast, another two amateurs, the philosophers Hilary Putnam and Jerry Fodor, both amateur psychologists, made a strong impact on psychology. Indeed, Putnam's popularization of Warren McCulloch's thesis that all mental processes are computations, and Fodor's that the mind is a collection of mutually independent modules, every one of them with a specific function or role, have been extraordinarily successful in academic brainless psychology.

Indeed, computational or information-processing psychology, as well as the Swiss knife metaphor, was hardly disputed until recently. Both ideas started to wane only when psychology fused with neuroscience. In fact, cognitive and affective neuroscience looks for *laws* of nature, not for incarnate computation *rules*, and connects the specialized regions of the brain instead of isolating them from one another. But the fact remains, that half a century ago most psychologists were taken in by the computer metaphor just because of the personal computer fad.

Such mass seduction might not have occurred if biological and social psychologists had done more serious theorizing in the vein of Donald Hebb's 1949 *Organization of Behavior*, or if the brain-imaging techniques had been invented earlier. But, for better or worse, history does not proceed logically and in a continuous manner. Worse, the gaps in it are often filled by trash. And, as recent research has shown, falsehood diffuses significantly farther, faster, deeper and more broadly than truth (Vosoughi et al. 2018).

2. From dilettantism to professionalism

Occasionally amateurs teach themselves what they need to know in order to become competent professionals. Democritus, Plato and Aristotle are so many outstanding cases in antiquity, Alhazen and ibn Khaldûn in the Middle Ages, Descartes and Robert Boyle in early modern times, and David Ricardo, Michael Faraday, Karl Marx, John Stuart Mill, Alexander

von Humboldt, Charles Darwin, and Lewis Morgan in the 19^{th} century. Mill was taught at home by his father, and Faraday attended only elementary school; Marx, who earned a law degree with a philosophical dissertation, became one of the most respected economists; Engels was an artillery graduate, and his book on the situation of the working class in England was perhaps the earliest work in empirical sociology; Humboldt studied mining and ended up by founding modern geography and ecology, and being the most famous naturalist of his time; Darwin studied theology at Cambridge but built evolutionary biology, which turned out to give the religious conception of life its coup de grâce; and Morgan, the earliest scientific student of the North American Indians, was a lawyer and businessman who taught himself Iroquois and befriended some aborigines before writing his influential *Ancient Society* (1877). All of the above-mentioned scientific innovators learned by themselves what they needed to become professionals. Presumably they made up for the lack of a mentor with a scientific outlook that they got from their wide-ranging readings.

Another remarkable self-made naturalist in Darwin's time was Piotr Kropotkin, the prince who started out as a cadet, and even acted as the Tsar's trusted personal assistant, to end up as a prolific naturalist, a revolutionist and an original political theorist. While under arms, Kropotkin participated in an exploration of the Altai mountain range, and discovered that it was parallel to the Himalayas, not perpendicular to them as the maps showed. *Nature,* the oldest and most prestigious scientific journal, published some of his naturalist's notes. And, at a time when competition was all the rage in biology and social science, Kropotkin pioneered the study of animal cooperation, and was thus one of the fathers of ethology. He also showed that in some species mutual help was just as instinctive as the struggle for survival. Among social animals, existence and coexistence are mutually dependent.

However, the most famous contemporary amateurs forced to become professionals were some politicians who were singularly unprepared to work as statesmen. Ernesto Che Guevara, a medical doctor, heroic guerrilla, and ultimately a martyr, was appointed minister of economy, and later of industries, in Fidel Castro's improvised government. Unsurprisingly, the Che failed at both jobs for lack of basic economic knowledge. He also failed in his last endeavor, namely trying to organize a peasant revolution in Bolivia, for the same reason, namely ignorance of the field: he did not start by finding out what the Bolivian peasants wanted and were prepared to do. Intelligence, enthusiasm, dedication, generosity and integrity cannot replace first-hand knowledge. Self-taught people can make their mark only in backward fields. Thus, none of the most original and influential

economists of the 19th century – David Ricardo, John Stuart Mill, Karl Marx, and Vilfredo Pareto – took courses in economics. They might not have made it in mature subjects like mathematics, physics, astronomy, or chemistry.

3. Amateurish slips of professionals: The case of Max Weber

When out of their ponds, professionals tend to utter howlers. Some of the *obiter dicta* of three famous authors – Max Weber, Noam Chomsky, and Steven Pinker – will suffice here. Weber was a professor of economics at the famous universities of Heidelberg and Vienna, but nobody remembers his contributions to that discipline. He is mainly remembered as the founder of economic sociology and the sociology of religion, and especially as the presumptive idealist alternative to Marx's historical materialism.

Amateurs tend to regard Weber's 1904 book *The Protestant Ethic and the Spirit of Capitalism* as a masterpiece, but serious historians either criticize or ignore it. Let us see why. The central thesis of Weber's most famous work was that Protestantism, particularly in its Calvinist version, generated the "spirit" of capitalism – something he did not describe. This hypothesis is open to the following objections.

Firstly, Weber failed to distinguish between two very different kinds of capitalism, commercial and industrial. Whereas industrial capitalism emerged fully only in the mid-eighteenth century, with the Industrial Revolution, commercial capitalism had existed already in the ancient world. Indeed, it may be argued that the Troy war was not over the beautiful albeit unfaithful Helen, but over the Troy-Cyprus trade route of the boats carrying copper from Cypriot mines. Likewise, the Punic wars may have been generated by the commercial competition between Rome and Carthage, a Phoenician outpost that offered such rare articles as glassware and toiletries, which the Romans craved but did not know how to manufacture.

The above interpretation of both ancient wars is materialist, but consistent with the thesis that they were basically trade wars financed by venture capitalists and insurance brokers, and supported by the Roman and Punic governments. Although priests must have tried to help their flocks, and must have attributed every military victory to the sacrifice offered to their divinities, the evidence only says that, as usual, the gods favored the strongest and wiliest.

Another objection to Weber's thesis on the capitalism-Calvinism connection is that the cradle of the Industrial Revolution was the small Anglican town of Manchester, not Geneva, the seat of the new Reformed Church. Granted, Calvin had encouraged the immigration of craftsmen specialized in manufacturing sophisticated articles like watches. But they were not industrial entrepreneurs. Industrial capitalism, which involves the large-scale production of affordable goods, such as cotton cloth, was born two centuries after Calvin read his sermons against luxury and money grabbing.

The cotton mills, financed by slave traders, and where workers toiled fourteen hours a day for pennies, were certainly not inspired by Calvin's stern sermons, but rather by the new commandment: "Thou shalt seek to maximize thy expected utilities." Granted, the competent capitalist managers knew how to save money, but they attained this goal by investing in new labor-saving devices and offering inducements rather than stuffing their mattresses with banknotes. Far from practicing the ethos of avarice, as Weber thought, the clever capitalist was a bold and innovating entrepreneur who sought and exploited new opportunities, in the way Joseph Schumpeter described.

Further, far from practicing asceticism and avoiding exhibitionism, the successful Mancunian capitalist joined the local foxhunting club, where he stabled his own charger – as the socialist Frederick Engels did while managing his family's cotton mill (Hunt 2009). Max Weber must have known some of this when he penned his most famous book, particularly since he admired industrialists as much as he despised *Junkers* or large landowners.

4. Chomsky's linguistic fantasies

Our next case is Noam Chomsky, the contemporary public intellectual best known for his brave criticisms of the American political establishment. His views on language and the mind were largely formed in reaction to the behaviorist or stimulus-response school. This school was still dominant in 1956, when Chomsky's first criticism of Skinner's hypothesis of language learning appeared. Contrary to Skinner, Chomsky held that humans are born possessing a grammar that allows them to understand and even identify the verbal stimuli they receive. For instance, a Chinese newborn would think "Aha, Mom is now speaking in Mandarin," whereas a London baby would think "Dad is talking to me in Cockney."

The reasoning that led Chomsky to opt for nativism in the age-old nature vs. nurture controversy was this: the verbal stimuli that infants

receive are insufficient to make them speak; hence language must be an innate faculty. Jean Piaget – who, unlike Chomsky, did study children firsthand – would object that there is a *tertium quid*, namely children's spontaneous creativity, as shown for example by their tendency to regularize verbs, as in "I goed to school" instead of "I went to school." In my view, Piaget's constructivist alternative to the nature/nurture dilemma nails both the nativist and the behaviorist coffins (Bunge 1984).

Chomsky expounded his nativist heterodoxy after having made his name in syntax, the branch of linguistics that, as Ferdinand de Saussure would say, studies the structure of *langage*, as distinct from *langue* or live speech. Moreover, Chomsky worked on syntax in isolation from both the study of meaning (semantics) and sociolinguistics, the study of speech as a communication tool and, in particular, a meaning-transfer mechanism. This detachment of syntax from semantics led Chomsky's school to ignore the empirical studies of Ursula Bellugi (1979), who found that the American Sign Language has roughly the same expressive power as spoken English, on top of which it is used to communicate with apes.

If speech (or its equivalent signing) is taken to be mainly a communication tool, one will tend to regard syntax as a study in fastidiousness. Ain't it so? *Sure, μαλιστα,конечно, certe, bien* sûr, *gewiss, senz'altro, desde luego, pois não.* The seal of correct translation is meaning invariance. *Innit Perfessor*?

Contents should always take precedence over form. And yet syntax, the study of linguistic form, is all of Chomsky's increasingly convoluted theories, none of which has served to analyze, let alone refine, the languages of mathematics or science, in particular the sciences of language. For example, Chomsky's theories do not help us understand what quantum physicists mean by 'observable' or by 'spin'. Since they ignore usage, syntacticians cannot even distinguish *you* as the second person singular pronoun from the generic *you* that occurs, for instance, in *Do not ignore meaning!* Incidentally, syntactitians focus on sentences, to the detriment of interrogatives, imperatives, and expletives.

Chomsky has not offered a clear concept of meaning because he believes that we do not need it, although he used it when stating that the most basic trait of our linguistic capacity is the ability to produce an unlimited number of sentences – all of them *meaningful*, of course. Moreover, Chomsky chided the philosophers who fell into the "trap" of searching for a reference function. But everyone uses some concept of meaning, for instance the <denotation, connotation>, or <reference, content> pair (Bunge 1974a). For example, neurologists see patients afflicted with either syntactic or semantic aphasia. The philosophical community might

not have tolerated existentialism if Heidegger had been diagnosed early on as being afflicted with semantic aphasia.

In the age-old strife between formalists (or structuralists), for whom form trumps contents and functionalists, who hold either that form should follow function or that both come together, Chomsky sides with the former, and thus comes close to the anthropological structuralists like Claude Lévi-Strauss. This is an interesting, albeit little-studied paradox: the convergence of Cartesian rationalism and postmodern irrationalism due to their shared apriorism and the concomitant disdain for the experimental and field studies of speech and the sign languages of humans and apes taught to punch computer keys to communicate with people.

In Chomsky's asocial and ahistorical view, language is "the window into the soul." No wonder that only about one percent of linguists in the world follow Chomsky when trying to discover how infants graduate from babbling to speech. Nor do they follow him when trying to discover how social changes cause speech changes – for example, England's Normans degendered nouns, as in the case of the conversion of "*le* vin est sur *la* table" into the neuter "*the* wine is on *the* table." A historical linguist might suggest that such degendering was a part of the Normans' attempt to simplify their French so as to be able to speak it and make themselves understood by their rude Saxon vassals.

Chomsky's indifference to development, evolution and history may come from his pre-Darwinian conception of man. In fact, he once asserted that talk of the evolution of language is just as absurd as talk of chemical evolution – which of course is a standard subject of both cosmology and molecular biology. Disregard for evolution led Chomsky to dismiss the developmental and evolutionary aspects of speech, in particular babbling and the calls of nonhuman primates.

Primatological research has found that infant marmosets and other primates babble, and that their parents ignore such crude attempts to communicate, while they react to correct calls. (Incidentally, think of the pedagogical discovery, that abstention from gratification trumps punishment.) Taking turns, another social trait of human speech, has also been observed in some nonhuman primates engaged in verbal communication (Snowdon 2017). In sum, the field and experimental studies of nonhuman primates have corrected the exclusive interest of philologists in human adult speech, to the exclusion of less evolved forms of communication. With hindsight we realize that Chomsky, though a deep and brave political journalist, is a failed linguist. Worse, the failure of his psycholinguistic fantasies may have led him to adopting a radically skeptical stance with

respect to the prospects of understanding both matter and mind (Chomsky 2009).

Steven Pinker (2002), Chomsky's best-known disciple, is a Harvard psychology professor who wrote a few bestsellers of popular science. In these books he divulged some of the most extravagant theses of pop evolutionary psychology, the successor of sociobiology, Edward Wilson's short-lived attempt (in 1975) to reduce the social to the biological.

In my view, Pinker has embraced all the wrong views of mind: Chomsky's nativism, Hilary Putnam's computationalism, Jerry Fodor's modularism, and pop evolutionary psychology. Pinker's original contribution is the thesis that all the most odious features of the contemporary capitalist societies are natural, in that they are in our genes. In particular ethnocentrism, greed, dominance, and violence would be universal, and family ties would always trump both material interests and fairness.

There are three problems with this thesis. To begin with, most children are not particularly greedy, violent, or ethnocentric. A second objection is that, as every anthropologist and social psychologist knows, humans are being encultured from birth: that is, we "internalize" the ruling behavior patterns, and are ridiculed, reprimanded or punished every time we violate them. The third major trouble with the claim that we are basically natural, or sculpted by our genes, is that geneticists have yet to identify the genes for greed, sexual violence, social standing, and so on. If aristocrats are "to the manor born," should we not look for manorial genes?

What anthropologists, sociologists and social historians did find long ago is that most social pathologies are present only in some societies at certain times. For example, a thousand years ago Norwegian warriors used to raid the English shores, kidnapping men to be enslaved, and women to have sex with. But today's Norwegians are among the nicest people in the world, even though their genomes are likely to be very similar to those of their brutal Viking ancestors.

Another telling statistic is this: the murder rate per 100,000 inhabitants is 0.4 in Japan, 1.6 in Canada, 4.8 in the US, and 25 in Panamá. Besides, almost all murderers are males – a fact that radical feminists might interpret as showing that females and males do not belong to the same species. So, why repeat the contention that human nature is everywhere the same and constant? Maybe because it is simpler and sells far better than the French Enlightenment's thesis, that human nature is even more malleable than canine or feline nature?

Lastly, let us take a quick look at some of the most recent and rewarding findings of developmental psycholinguistics, the discipline

which, contrary to the Chomsky-Pinker apriorism, studies the way human brains learn to speak (e.g., Werker & Hensch 2015). The main lessons of developmental neurolinguistics follow.

1/ We begin life with a mental blank slate but with a brain that, in a normal linguistic environment, will learn any natural language. If such an environment is poor, as is the case with boathouses and orphanages, so will be the subject's linguistic skills.

2/ There are certain critical periods during which our linguistic apparatus is most responsive to environmental inputs. For instance, babbling starts at 7-10 months, and by 4-5 years of age children can understand and produce most linguistic items. For example, English and Japanese children distinguish /r/ from /l/ at an early age, whereas Japanese adults have a hard time distinguishing "late" from "rate".

3/ The said windows are not fixed: certain neural processes open them, keep them open, close them, and allow them to be reopened. In short, the so-called language faculty does exist but it is not hard-wired. Most of what holds for language also holds for other abilities.

In short, as Santiago Ramón y Cajal surmised in 1928, the human brain is plastic, that is, it learns and unlearns with experience. In other words, the nature/nurture distinction is correct at any given point in development, but it is fluid over time. In particular, what began as artificial second nature may solidify for a while, but may get lost if unused. Use it or lose it!

5. Amateurs in politics

Ideally, professional politicians should undertake serious studies of political science and its companions – sociology, economics, and historiography. Regrettably, this has very seldom happened: most political leaders at all times have studied at most law or history, and they have not bothered to investigate the socioeconomic issues that need addressing seriously, that is, scientifically. In other words, most professional politicians have been amateur social activists.

Take for example Vladimir Ilich Lenin, the leader of the 1917 October revolution. This world-shaking event caught him in Zürich while plowing through Hegel's dense *Logic,* instead of reading the recent social science literature. Some years later, when asked why the revolution occurred in

Russia rather than in England or in Germany, where the socialist movement was much more advanced, he answered with a metaphor: because "Russia was the weakest link in the imperialist chain." His defeated antagonist, the Menshevik leader Aleksandr Kerensky, got it right for once: the Bolsheviks won the popular support because they promised peace, bread, and land – just what the people needed and wanted after nearly four years of misery.

When campaigning for electrification, Lenin coined the formula "Socialism = Soviet power + Electrification." He did not mention popular participation – the marrow of democracy, which ought to be central to authentic socialism. The Bolsheviks won largely because they coined winning battle cries, but they failed to construct an authentically Socialist society because Marx, Engels and Lenin believed that socialism would emerge spontaneously, without popular participation. They dubbed "utopian" any attempt to plan the new society – as if it could emerge from economic transformations alone. Yet they did plan the modernization of their heavy industry, which thrived at a time when factories were closing elsewhere.

Let us now peek at the other side. Woodrow Wilson was the only American president with a doctorate in political science. He sympathized with the KKK, yet his presidency was on the whole progressive until World War I. From then on Wilson caught the imperialist bug and committed four political crimes: he persecuted trade unions and anti-war protesters, hounded the German Americans, sent troops to intervene in the Russian civil war, and connived with Georges Clemenceau and Lloyd George to distribute the war spoils among the victorious empires and to hatch the Treaty of Versailles, which gave the Nazis a pretext to launch World War II. There is nothing like war to fan unselfish comradeship and win votes, stir hatred of the "enemy," and rally people around the flag regardless of justice.

The same century that gave us mass murderers also produced Mahatma Gandhi, Ho Chi Minh and Nelson Mandela, along with a bevy of political martyrs, from Francisco Madero, Emiliano Zapata, Augusto Sandino and Patrice Lubumba to Ernesto Che Guevara. All these men dedicated their lives to improving the lot of the downtrodden. But, whereas Gandhi, Ho and Mandela were professional politicians, Guevara was an amateur – a physician urged to head the ministries of economy and industry, and who later on started a guerrilla movement intent on emancipating the Bolivian peasants.

Che's only political credential had been having accompanied the Castro brothers in the long march that took them from the Sierra Maestra

wilderness to the presidential palace occupied by General Fulgencio Batista. This was the dictator installed by the US government for the benefit of the sugar cane barons and the mob, particularly the casino and brothel owners like Meyer Lansky and Lucky Luciano. Even the noble Franklin D. Roosevelt, when warned that Batista was a crook, replied: "He certainly is a SOB. But he is *our* SOB." Imperial ambition degrades even the greatest, from the philosopher-emperor Marcus Aurelius onwards.

The first thing Che did as the new Economy Minister was to ask for the advice of Raúl Prebisch, the best Argentine economist at the time, whom he only knew by reputation. (Che's letter, handwritten on leaves of a school exercise book, holds the pride of place among Prebisch's memorabilia.) Having known Prebisch intimately, I guess his advice was: "You should produce yourselves whatever you consume. This will entail diversifying agriculture and starting local industry." Che adopted this policy, but the Soviet advisers objected, promising to pay for sugar more than the international price – a promise they kept. So, he resigned his position and decided to move on, trying to export the Cuban revolution.

Che tried to start the Bolivian guerrilla movement without having investigated the conditions, aspirations and fighting potential of the people he wished to help. This time the CIA did their homework, and had the Che murdered and his group smashed. The moral of this story is: *Heroism + Ignorance = Foolhardiness.*

6. Revolutionaries and statesmen

Let us list the main successful revolutionary movements of the 20th century: the Mexican revolution (1910-1920), the second Russian revolution (1917-22), the Indian civil disobedience movement (1918 -1947), the Chinese revolution (1927-49), the second Cuban revolution (1953-1959), the Vietnamese war against the French, Japanese and American occupiers (1945-1975), the Algerian war of independence (1954-1962), the anti-Apartheid struggle (1955-1994), and the revolt against the Soviet rule West of the Western border (1956-1990). The leaders of most of these national independence movements were amateur politicians, and none of them received military training or held office before their final victory.

The successful revolutionay seldom if ever makes a good statesman. Thus neither Madero, nor Zapata nor Villa sat on the Mexican president's chair. Lenin, the brilliant tactician who electrified the urban toiling masses with his speeches, reneged on some of his key promises when building the new state power on the debris of the Soviets (revolutionary elected councils) that he had dismantled after they led him to power. Mahatma

Gandhi led the civil disobedience movement that led to India's independence, but wisely declined to take part in the new government inugurated in 1947. Mao Zedong, during two decades, fought the landowners and moneylenders as well as the Japanese invaders. But when he took the reins of government (1949), he dragged it from one economic disaster to the next. In 1959, Fidel Castro's small revolutionary group replaced the clique that the Americans had installed, chased away the gambling and prostitution rings, and rebuilt Cuban society along far more just ways, but made many mistakes, largely for relying on the advice of his Soviet benefactors. After defeating the French and American armies in 1975, Ho Chi Minh and his comrades replaced the unpopular South Vietnamese government and attempted to repair their country, that had been ravaged, decimated, and looted by three imperial powers – France, Japan, and the USA. Finally, in 1994 the South African President Frederic de Klerk freed Nelson Mandela and handed the power over to the Black opposition, which at this time is still learning how to govern.

In sum, between 1910 and 1994, at least seven groups of freedom fighters on four continents overcame their far better trained and armed enemies. None of the leaders of these popular movements, not even the legendary General Giap – of Dien Bien Phu fame – had received military instruction, nearly all of them spent time in enemy dungeons, and none of them made money out of politics. All of the above-mentioned leaders were brilliant, in some cases even heroic fighters, but poor statesmen. Why this disparity?

I suggest that building a new state takes very different personal traits than fighting the ruling power: it takes technical knowledge of the state machinery, managerial skills, and teamwork – which involves more asking for advice than offering it. The charismatic and victorious leaders tend to surround themselves with courtiers, and they do not inherit a competent and honest civil service bold enough to raise objections or at least drag their feet when disagreeing with the party line. Worse, many of the public servants inherited from dictatorships are kept in place just because they know how to operate the state repression machine – like the proverbial Fouché and Talleyrand. When the conquest of power trumps everything else, all the other values are trampled on, as Machiavelli might have said.

10. Crime, Criminology, and Penology

Around 1900 criminology was ruled by the dogma of the born criminal, which the great writer Emile Zola had popularized in his novels *Les Rougon-Macquard*, the story of a criminal dinasty. It used to be taken for granted that this was a case of biological inheritance, although it may well have been a case of the well-known process of adopting the profession which had brought fame or riches to some of the ancestors, as in the cases of financiers like the Rothschilds and the Rockefellers, as well as in those of some musicians, painters, scientists, medics, teachers, politicians, and warriors. In these cases, what are being transmitted are not genes but know-how, connections, or money.

A century ago, the chief theorists of inborn criminality were the anthropologist Cesare Lombroso and his son-in-law, Enrico Ferri. Both were so famous, that they were inducted into many learned societies around the world, and every time an important criminal was caught, the popular press published his "Lombrosian profile": a cartoon showing a man with a narrow forehead, deeply set eyes, outstanding ears, and so on. This idea is so popular, that the expression *figure patibulaire*, or gallows face, is entrenched in the French language.

Taking advantage of his attendance at the International Medical Congress in Moscow in 1897, Lombroso visited the great novelist Leo Tolstoy, who had just published *Resurrection*, an eloquent indictment of the thesis that prostitution is innate and unredeemable. Contrary to his visitor, Tolstoy held that criminals are not born but made: that they are victims of their society, so that they can be reeducated. This thesis had been defended during the Enlightenment by the eminent Italian jurist Cesare Beccaria, an eloquent critic of the death penalty.

Back to Tolstoy and his visitor. The great man became furious when hearing Lombroso's view on criminality. When his visitor left, Tolstoy confided to his diary that he regarded him as "an old fool." Back home, Lombroso wrote on his diary his own impression of the great writer: "an old imbecile" (Mazzarello 2011).

This is funny but it concerns a dramatic problem, for Platonic nativism, though discredited by scientific psychology, has recently been refloated by genetic determinists like Richard Dawkins, Noam Chomsky, Steve Pinker, Jesús Mosterín, and the pop evolutionary psychologists (e.g., Buss 2015).

All of them repeat the ancient doctrine that we are born with certain ideas and dispositions, which neither experience nor education can alter. Of course, they do not bother to exhibit any solid evidence.

Those popular writers did not dare to revive Lombroso's born criminal, but their basic idea is the same, namely, that there is an immutable human nature: that an individual's development only unpacks the innate abilities and disabilities etched on their genomes. This is why it has been said that their doctrine can be summed up in the formula "Genome is destiny." Clearly, this belief is a variant of fatalism; its opposite, voluntarism, involves the free will hypothesis.

The criminological implication of nativism is clear: criminality is in the genome, and consequently the only effective way to deal with criminals is to detect, catch, and confine or even execute them. Hence the unscientific justification of the most strict prison regime, solitary confinement included, and perhaps sleep deprivation and water-boarding as well. For the same reason, the preachings of penal reformers like Cesare Beccaría, John Howard and Leo Tolstoy would be inefficient in the best of cases: you can't alter human nature (e.g., Pinker 2002).

Fortunately, most contemporary criminologists have not listened to the genetic fatalists. In fact, the dominant thesis in criminology, as in psychology and education science, is that human behavior is eminently plastic and it results from four factors, not just one: heredity, education, social environment, and will. Consequently, crime is just as controllable as health and learning.

To test this thesis, one should look at the statistics on homicide with firearms. The figures are eloquent: the murder rate is lowest in Japan and highest in the banana republics; and the American rate is three times that of Canada. Since the murderers in all these countries belong to the same biological species, they ought to share the same human nature, and therefore they ought to behave in roughly the same manner in matters of life and death – but they don't. For example, the Japanese gave up the samurai's habits, whereas the Central-Americans practice them much more efficiently, because they use sophisticated guns rather than the engraved steel sabers we admire in Japanese museums. If we wish to see far more lethal and sophisticated weapons, we should visit a Swiss train station on a Sunday afternoon. There we'll see men carrying bazookas or machine guns, returning home from their compulsory military practices. They are not expected to use them at home. Like the Athenians praised by Pericles, and unlike the Spartans, the Swiss do not mail-order weapons and don't carry them in public because they are civilized.

Classical criminology was a game of catching, judging, and punishing. This is why, until recently, crime was a subject for psychiatrists, penalists, experts in public security, and politicians anxious to gain votes by looking "tough on crime." This is why in 1994 President Clinton signed the "Three strikes and you are out" decree, whereby committing three petty crimes, such as stealing a slice of pizza, was enough to be jailed for life. The net effect of this rule is that the USA is the country with the highest incarceration rate in the world: 1 percent of the population is in jail, and one in every 31 individuals is under "correctional supervision." Thus, about 10% of the American population works in or near the crime industry, to the sole benefit of private prisons, arms dealers, and vote-hungry politicians.

The status of criminology changed radically about 1980, when Anthony Bottoms, Terry Moffit and Per-Olov Wiktröm in Sweden and Britain, Rolf Loeber and Robert Sampson in the USA, Marc Le Blanc in Canada, and a few others elsewhere, adopted a scientific stance in studying both the genesis and prevention of crime, as well as the rehabilitation of ex-convicts. They freed criminology from its traditional legal cage, and put it into close contact with genetics, neuroscience, psychology, and sociology: look at Fig. 10.1.

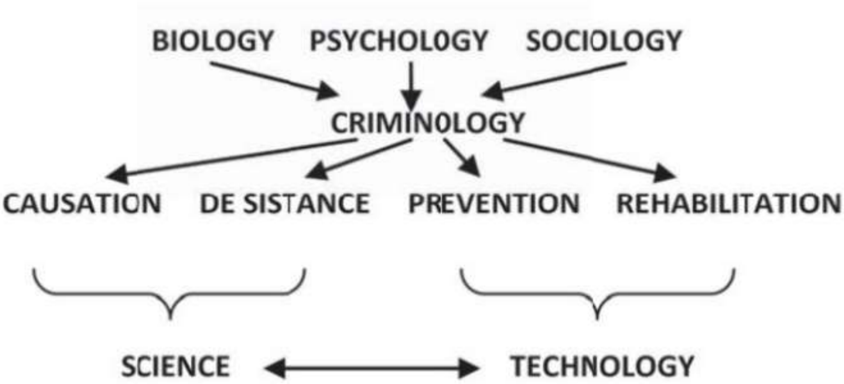

Fig. 10.1 The basic sciences that feed criminology, an applied science which in turn feeds such technologies as penology, which includes correctional management

For example, neuroscience teaches us that the organ that makes the decision to either commit a crime or desist is the prefrontal cortex, which does not fully mature before the age of 22; psychology shows that such a decision is a voluntary act preceded by an evaluation, both moral and practical, of the possible benefits and risks of the crime being contemplated;

and sociology proposes a description of the criminal's habitat, particularly the delinquent's neighborhood and network.

Wikström in Cambridge and Sampson in Harvard have stood out for tackling tough crime-related problems, imagining original models, and putting them into practice in neighborhoods of Boston and Chicago with a reputation of harboring delinquents and drug trafickers. To have some efficacy, the criminologist's intervention will have to involve some respected members of the community, willing to guide children and adolescents, as well as policemen ready to participate in such encounters instead of threatening children.

An early and little-known penological reform of this kind was carried out in the Soviet Union in 1959 at the instigation of Nikita Khrushchev, who not only denounced Stalin's mistakes and crimes during a whole generation, but also stated that "real socialism" was not such, and proposed a vast social reform. This included the replacement of incarceration with reeducation and "tribunals of comrades," NGOs charged with counseling newly freed criminals (Fontana 2017: 357). This progressive project, rooted in the new leadership's belief in the basic decency of humans, did not go much beyond emptying the jails that had been filled by victims of Stalin's paranoia, but it initiated a much freer and optimistic era, clouded only by the fear of a nuclear war.

Before planning any crime-preventing intervention, the criminologist will have to form a clear idea about the causes and circumstances of acts of crime. That is, efficient action will have to be planned scientifically rather than on the basis of tradition or in the heat of a political campaign. And this, in turn, requires overcoming the bias against planning that was cultivated during the Cold War to give the impression that planning threatens freedom, while in fact unplanned action is irrational and therefore inefficient.

Wikström proposed his own situational theory of crime, where the key word 'situational' suggests that the delinquent's action depends critically on the criminal's situation: being employed o unemployed, belonging or not to a gang of professional criminals and, above all, being or not being offered a temptation. Recall the Spanish popular saying *La ocasión hace al ladrón – Occasion makes the thief.*

Disposition		Dissuation
&	> Options & elections <	
Situation		Temptations & provocations
		< Offense Other

Fig. 10.3 Situational theory: P.-O. Wikström & R. Sampson, 2003

Unlike the fantasies about the invariable human nature, Wikström's theory can be confronted with reality. It may also guide social workers intent on keeping an eye on potential criminals as well as helping them, since they can change their situation or circumstances. This is where Ortega y Gasset's famous sentence "I am I and my circumstances" applies. If an individual's circumstances are altered, for instance through inclusion or education, his social behavior is likely to change as well. For example, the wretched Adolf Eichmann tried in Jerusalem was not the same haughty S.S. *Obersturmbannführer* who had managed the corpse factories.

Wikström notes that such changes won't suffice to effect profound and lasting alterations: these also require the individual's active participation – that he performs by himself the evaluations required to make the decisions that will lead him to either commit an act of crime or to desist. After all, contrary to both the predestination doctrine and behaviorist psychology, every one of us enjoys a measure of free will (see Ibáñez 2017). Consequently, when committing a crime we do not just break a social convention, but we also violate a moral principle, such as "Thou shalt not kill." Incidentally, this commandment occurs in the Bible but it refers only to one's fellow tribesmen: the biblical God is supposed to have all infidels, homosexuals and adulterous women killed.

In any event, the reconciliation of modern criminology with moral philosophy is one of the causes in the changes operated since the 18th century civil and penal codes. Regrettably, professional philosophers have not contributed to such changes. For example, the pragmatist Jeremy Bentham invented the panopticon, to better watch over the prison inmates, and the nihilist Friedrich Nietzsche rejected the good/evil dichotomy, while ethics students are expected to study the dilemmas posed by a trolley out of control, instead of tackling bulky moral problems, such as the volunteer worker who may have to bribe the local tyrant to secure the safe passage of a relief convoy, or to accept a food donation whose free distribution is bound to discourage local farming.

Some individuals in the pro-science party have suggested that all crimes should be assigned probabilities. Actually this is done every time an accused is either condemned or exonerated on the strength of his reincidence probability. But such an evaluation is subjective, hence unscientific, since it presupposes that crimes occur randomly, just like the chance encounters in public spaces with old friends or with celebrities.

Actually every act of crime, far from being a random occurrence, is deliberate, even when impulsive. Hence the sanctions based on reincidence probabilities are groundless. In other words, the so-called trial

by numbers is just as intuitive, hence unscientific, as the trial based on shaky evidence such as denunciation or eyewitness testimonial.

So much for small-scale crimes, those committed by single individuals or by gangs like the mob families. Large-scale crimes, those committed by statesmen when dismantling social services, attacking NGOs, reneging on election promises, persecuting presumed dissidents, or starting military aggressions, fall outside criminology: they are studied by political science and historiography. Regrettably, most of these experts have taken such crimes in their stride, invoking the moral neutrality of science. I submit that they are mistaken: that objectivity, far from involving moral indifference, requires moral partisanship. For example, the objective historian will admit that bombing civilian populations is a war crime.

Political crimes are far worse than small-scale crimes because their goal is to terrorize and subject whole populations, not just some individuals. This difference, which underlies the radical difference between a war-crimes tribunal and an ordinary court of justice, will escape a methodological individualist, for whom a war crime is just the sum of many homicides.

In sum, criminology is in the intersection between applied science and technology. The scientific approach to it has yielded not only a deeper understanding of the act of crime, but also the means to prevent it, as well as helping the reinsertion of the criminal into society. By contrast, the doctrine of the born criminal fails to account for the overnight conversion of uncounted peaceful individuals into merciless crusaders proud of assassinating unarmed infidels, dissenters, or "terrorist" victims of both fanaticism and exclusion. So, Cesare Beccaría, John Howard and Leo Tolstoy were right: criminals are made, not born, and they are redeemable.

To conclude, if delinquents are locked up in warden Bentham's panopticon, they are unlikely to redeem themselves, but they have a chance of redemption if counseled by brother Spinoza and helped by NGOs specialized in the community control of violence. That this policy works has recently been shown by a study of 264 American cities spanning more than two decades (Sharkey *et al.* 2017). The results are eloquent: the addition of 10 organizations focusing on community life and crime led to a 9% reduction in the murder rate, a 6% reduction of violent crime rate, and a 4% reduction of theft. In short, helping people is more effective than treating them as suspects. An old saying puts it thus: If you treat people as knaves, they will behave as knaves.

11. Gravitational Waves and the Nature of Space

The detection of gravitational waves by the LIGO team which involved 950 investigators and cost around one billion US dollars was the scientific star of the year 2015. What, if any, is the philosophical impact of this scientific breakthrough, which Albert Einstein had anticipated one century earlier? To answer this question we shall start by examining the central equations of Einstein's theory of gravitation, also known as general relativity.

1. Einstein's theory of gravitation

Einstein's theory of gravitation can be summed up in the ten equations

$$G_{ik} := -\kappa T_{ik}, \text{ where } i, k = 0, 1, 2, 3. [1]$$

The lefthand side, Einstein's tensor, describes the curvature of spacetime, whereas the tensor T_{ik} in the righthand side describes the distribution of the energy and momentum of the material source of the gravitational field – for instance a gas jet, a light beam, or whatever else there may be in the region that is being explored. G vanishes when spacetime is flat, and T is null wherever there is nothing. As for κ, it is a universal constant proportional to Newton's G.

The equations [1] are numerical identities, but the meanings of their two sides are different. (The whole point of writing *equalities* like [1], rather than *identities* like "0+1=1+0", is to relate different concepts. The same holds, of course, for inequalities. Identities involve the = symbol, whereas equalities involve the assignment relation :=, as in "sin π/2:=1." In an identity like "0 = 0," or "1 = the succesor of 0," both sides are intersubstitutable *salva veritate*. Not so in an equality such as Newton's second law "F:= ma." In short: the equality or assignment concept ":=" is not a symmetric relation; that is, "A:=B" is not the same as "B:=A".)

Whereas the lefthand side of [1] is a geometric construct out of the metric tensor occurring in the line element *ds*, the righthand side represents a composite of physical attributes such as energy density and

momentum. Consequently, reading [1] from left to right is not the same as reading it from right to left. Indeed,

Left to Right Spacetime curvature affects matter.
Right to Left Matter curves spacetime.

These two readings or interpretations have been synthesized into the famous formula "Geometry tells matter how to move, and matter tells geometry how to bend" (Misner et al.1973.)

The preceding sentence implies the puzzling idea that abstract objects, like geometric concepts, have causal powers, such as that of affecting material ones. Obviously, this conclusion must be as unacceptable to idealists as to materialists: both parties should demand that the two sides of an equation have the same ontological status – either abstract or concrete. This condition, usually met tacitly, may be called that of *ontological homogeneity*, analogous to the condition of dimensional homogeneity.

Note that so far we have not said what the equations [1] are about, whereas Aristotle rightly enjoined us to start every discourse by announcing what it will refer to. Obviously, Einstein knew what he was referring to when he wrote the equations [1], namely the gravitational field and its sources. That field had been mentioned though not worked out by Bernhard Riemann half a centuy earlier.

Those equations are the gravitational counterpart of the Poisson equation $\Delta\varphi = 4\pi\rho$ for the classical electrostatic field φ generated by the distribution ρ of electric charges. In the case of gravitation, G is the analog of φ, and T is parallel to ρ. As for the laplacian $\Delta = \nabla^2$, it is the slope of a slope.

In the case of gravitation, the metric tensor g_{ik} is analogous to the electric potential φ, whereas the stress-energy tensor T is parallel to the charge density ρ. For propagating fields, whether gravitational or electromagnetic, the operator Δ is generalized to the four-dimensional d'Alembertian operator $\Box = \Delta - (1/c^2)\partial^2/dt^2$, the signature of a wave traveling at the speed c of light in vacuo.

The differences between gravitation and electromagnetism are just as interesting as their analogies. For one thing gravity, along with energy, is the only property shared by lumps of matter of all kinds. By contrast, electrodynamics holds only for electrified matter – particles, currents, and their fields; correspondingly, Maxwell's field equations have a single general solution. By contrast, Einstein's equations for the gravitational field have no general solution because the stress-energy tensor T takes on

different forms for different kinds of matter. Hence, far from being a universal theory like Maxwell's, Einstein's theory of gravitation is stuff-dependent or constitutive. In conclusion, the universal/stuff-dependent contrast that holds for properties does not carry over to the corresponding theories.

Einstein's reading of his equations [1] is embraced by all but the minority of physicists and philosophers who reject the concepts of matter and of gravitational field, notably Misner, Thorne & Wheeler (1973) in their monumental treatise on the subject. Ignoring the distinction Leibniz drew in 1704 between truths of reason and truths of fact, they hold that Einstein's equations are purely geometric.

This claim is part of the geometrization of physics – a program first proposed in 1876 by the great mathematician William K. Clifford, and revived by J.A. Wheeler's geometrodynamics (1962). Wheeler also stated that the building blocs of the universe are propositions; that "its" (concrete things) are clumps of bits or information units; and that observers participate in keeping the physical universe running (Barrow et al 2004). But neither Wheeler nor his associates produced any evidence for these anthropocentric excentricities. I will argue that the detection of gravitational waves is only the latest of a string of facts and arguments against the matter-without-matter program. Instead of geometrizing physics, these developments have physicalized Riemann's geometry.

2. Enter gravitational waves

Shortly after inventing his theory of gravitation in 1915, Albert Einstein realized that it entailed the existence of gravitational waves. This finding elicited many discussions in the physics community. Several ingenious devices were designed over the years to detect them until the LIGO team, which designed and built a huge set of crossed laser interferometers, struck gold (Abbott et al. 2016).

How has this discovery affected the standard evaluation of Einstein's 1915 theory of gravitation as the best we have got? A first answer is of course that the discovery in question has once more corroborated Einstein's theory, since only the latter predicted the existence of those waves a full century in advance, along with some twenty other "effects," among them the fact that light loses energy when climbing against a gravitational field, as when a flashlight is pointed upwards.

Still, a questioning mind will also ask what a gravitational wave is: a ripple in a pre-existing gravitational field, or a ripple in spacetime and therefore also the alternate shrinking and expansion of the instruments used to explore it, such as rulers, timekeepers, and interferometers? To

answer this question we only need to look again at equation [1] above and the two readings of it: spacetime curvature → matter, and matter → spacetime curvature.

Since both readings are legitimate, we conclude that a gravitational wave is a gravitational field spreading out as well as a ripple in spacetime. Thus, every time a gravitational wave struck LIGO's huge crossed interferometers, these oscillated, and the portion of spacetime they were immersed in trembled like a jello ball.

This answer may incite the questioning mind to ask a further question, namely what has LIGO taught us about the nature of spacetime: is it only a grid useful for situating events, or is it just as material as its contents, such as atoms, galaxies, light beams and things?

3. Inside a hollow sphere

To help us answer the question that closes the previous section, consider a hollow sphere, or else an empty shell protected by a thick sheet of insulating material. As we know, gravitation vanishes in that hole. Commonsense adds that only spacetime, or at least space, remains. Further, this space is flat, for wherever T vanishes so does G, and $G = 0$ is the signature of a Minkowski or pseudo-Euclidean spacetime.

Let us now rethink the LIGO experiment in light of the above. If we grant that a gravitational wave involves the propagation of a gravitational field as well as a spacetime ripple, and since material objects, and only they are changeable – as Heraclitus taught us –, we must also grant the logical consequence, namely that spacetime is material and thus real (or subject-free) as well.

Our argument may be recast into the following linked syllogisms.

First argument

1 Gravitational waves activate their detectors;
2. Detectors react only to specific material stimuli;
3. LIGO has detected gravitational waves.
Hence, gravitational waves are material.

Second argument

1 Gravitational waves are ripples in spacetime as well as fields spreading out;
2 Whatever is changeable is material and vice versa;s
3. LIGO has detected local changes in spacetime.
Hence, spacetime is material.

The last conclusion contradicts the popular opinion that spacetime is the passive and immaterial container of all existents. By the same token, it also contradicts all the varities of immaterialism, including the phenomenalism of Berkeley, Kant, and their positivist offspring, as well as the geometric theory of matter. On the other hand, the thesis that spacetime is just as material as its contents, might have been admitted by Einstein, for he stated explicitly that there would be no metric tensor g_{ik} anywhere if the matter tensor T_{ik} were to vanish everywhere, so that a hollow universe would be impossible.

Before the birth of Einstein's theory of gravitation, place in empty spacetime could be regarded as immaterial in both senses of this word, that is, as being stuff-free and unimportant. In other words, all points in spacetime would be equivalent, or transformable into one another by a linear transformation. But if space is material, then different places may differ in the values of the matter tensor T_{ik} at them, so that place may matter after all

Let us conclude by asking the hardest question: What becomes of spacetime when matter vanishes, as in the case of a hollow sphere? Since there is nothing real between two geometric points in that hole, their physical distance must be null according to any relational conception of space and time. That is, inside the hollow sphere the physical distance element $d^*s = 0$, and *a fortiori* the physical metric tensor $g^*_{ik} = 0$. In other words, inside a hollow sphere spacetime vanishes along with matter. It is fair to bet that this radical view won't be popular (see Romero 2018).

Worse, the "no space remains" solution proposed above is untestable, for the introduction of a probe into the sphere would destroy the original vacuum. But the conventional hypothesis, that the space inside the sphere is flat (or Euclidean) is just as untestable for the same reason. Since at this time we cannot imagine a crucial experiment allowing us to decide between the two contending hypotheses, I suggest suspending our final judgment for the time being.

In the meantime we might step down to the level of the fluctuating vacuum of quantum electrodynamics, with its small but measurable Lamb shift and Casimir force. So far as I know, nobody knows what becomes of space when only the quantum vacuum remains. However, this new problem is big enough to deserve being tackled by a further research project.

12. Is Scientific Philosophy Possible?

Although science is arguably the engine of modern culture, it has always occupied a rather modest place, it is despised or even vilified by the dominant neoliberal party, and is still a minor player because it involves unusual and counterintuitive ideas, and seldom yields useful products.

As the biologist Lewis Wolpert (1989) put it, science is highly *unnatural*. Indeed, consider the following rough sketches covering the last twenty thousand years of Western thought. Notice the long gap between Justinian's theocracy and the Renaissance, when Greek science and the humanities took refuge in the Islamic world. Notice also that some of the fields mentioned below overlap partially. For example, applied science bridged basic science and technology, and scientific psychology is in the intersection of neuroscience with social science. Here is a sketchy list of the main types of knowledge.

500 BPE-1500	*PE1500-PRESENT*
Mythology	Mythology
Ordinary knowledge	Ordinary knowledge
Artisanal knowl.	Artisanal knowledge
Protoscience	Science
————	Technology
Humanities	Humanities

A scientific philosophy would of course be one built in the "spirit" of science, compatible with the science of the day, and favoring the advancement of science. Such a philosophy was promised a few times in the past, but so far very few candidates to such a title have passed the test. For example, it was one of Charles S. Peirce's unfinished projects, and between 1877 and 1916 there was even a German journal with that name; but its editor, the philosopher Richard Avenarius, taught a subjective idealism akin to Mach's, and his journal left hardly any traces. In the next generation, Edmund Husserl [1995: 31] claimed that his phenomenology, aka egology, was a "rigorous science," but also the very opposite of what passed for science in his time, since it was subjectivistic and started by

"putting the world in parenthesis," that is, pretending that it does not exist – hence not worth being investigated.

In the 1920s, a group of central-European scientists and philosophers gathered in the Ernst Mach Verein, aka the Vienna Circle (1924-1938). These scholars attempted to revamp Mach's phenomenalism with a strong dose of scientism and the recently born mathematical logic. Hans Reichenbach's *The Rise of Scientific Philosophy* (1951) summarized their thought. Regrettably, this book was philosophically indigent; for example, its chapter on time tells us how to measure time intervals, not what time is.

The logical empiricists did not accomplish much, but were the only antidote to the ruling unscientific philosophies of their time – Thomism, intuitionism, existentialism, phenomenology, and dialectical materialism. Anyway, in 1938 the Austrian logical positivists dispersed and emigrated due to the annexation of Austria by the Nazis, those mortal enemies of rationality, science, and the social democracy professed by most of the members of the Vienna Circle. Shortly thereafter their admirer, the logician Willard Van Quine, hoped that his "naturalization" program would render philosophy scientific. Actually it only produced a brief renaissance of nominalism, centered on the substitution of signs for concepts – in particular talk of sentences and languages instead of propositions and theories respectively – a strategy that bypasses the designation relation, which occurs, e.g., in "the numeral 1 designates the follower of the number zero," or "Let *ABC* designate the triangle with vertices *A, B*, and *C*."

In short, the early scientific philosophy project was rather short-lived, but it was resumed two decades later by the present author, who expounded it in his eight-volume *Treatise on Basic Philosophy* (1974-1989) plus about twenty additional volumes on the philosophies of mathematics, physics, biology, psychology, social science, and politics. The present volume is but the latest in a half-century-long quest for a clear philosophical system compatible with the bulk of contemporary scientific knowledge. This was also an attempt to defang, cleanse and update dialectical materialism, the work of social scientists bedazzled by Hegel's hermetic nonsense and ignorant of the exact sciences.

In the balance of this book I will attempt to persuade the reader that scientific philosophy is not just possible, but that it already exists, if only *in statu nascendi*. Our treatment will be synoptical: it will be confined to listing the main philosophical disciplines and sketching a couple of topical problems in each of them.

1. Logics

There are several systems of logic, among them the classical, intuitionist, modal, and quantum ones. But only the first of them, also called the classical predicate calculus, is used in both ordinary mathematics and the factual sciences. Although that logic is said to be two-valued, in that it admits only two truth-values T and F, actually it is a theory of deductive inference, not of truth. So much so, that it underlies the various theories of partial truth that have been proposed to handle partial or approximate truths like "$\pi = 3$" and "Planet Earth is spherical." A deduction may be valid or invalid regardless of the truth-values of the propositions it involves. The truth tables are only heuristic and didactic props. And none of the alternative or non-classical logics, such as the intuitionist and modal logics, has been used with profit in the factual sciences: they are either arcane tools in the foundations of mathematics, or just *jeux d'esprit*. Here we shall mean by 'logic' only the so-called classical predicate calculus.

The main rule of valid logical inference is the so-called *modus ponens*: "If A, then B. Now, A. Hence, B." This is the spine of the hypothetico-deductive method. Indeed, to test a hypothesis of the form "If A, then B," one materializes the antecedent A and checks whether the consequent B occurs as conjectured. If it does, the conditional has been confirmed; otherwise, that is, if B fails to occur, then not-A is inferred – a case of *modus tollens*. The cybernetic analog of the *modus ponens* is the positive feedback, and that of the modus tollens is the negative feedback.

Both rules of inference are often violated in ordinary discourse and even in the scientific literature, where fallacies of the form "$[(A \Rightarrow B) \& B] \Rightarrow A$," called "affirmation of the consequent", are often found. Ironically, the Scientific Revolution was accompanied by the rejection of the correct syllogistic logic, whereas the contemporary rejection of the scientific stance is often accompanied by logical imperialism – the fallacy that logic is omniscient.

It is generally assumed that logic is the supreme guardian of rigor – in other words, the best guarantee against nonsense and inconsistency. But this opinion is mistaken because logic, precisely for being topic-neutral, is indifferent to truth and falsity – as Russell and Whitehead (1962) pointed out.

On the other hand, logic demands minimal vagueness or, equivalently, maximal exactness. This demand is met only by mathematics. Just think of the plethora of vague terms in other fields as well as in ordinary language. Let the following sample suffice: contradiction, dialectics, equality, evidence,

fact, force, opposite, paradigm, phenomenon, probability, structure, and theory.

Worse, logic postulates the principle of addition, which tolerates arbitrary irrelevancies. Indeed, this principle states that an arbitrary proposition A implies A or B, where B need not be related to A. For example, let p design a theorem in some mathematical theory. According to the theorem of addition, if p, then p or God is almighty. Thus the appearance is created that mathematics can be mixed with theology. Though formally valid, this argument is semantically fallacious for mixing disjoint universes of discourse (Bunge 2003).

So, logic justifies conceptual smuggling. Relevance logic (Anderson & Belnap 1975) was invented to prevent such contraband, but failed because it retained the principle of addition – the door through which irrelevances can be smuggled. The realization that the concept of relevance is semantic rather than formal will lead to the search for a condition preventing the said contraband.

The present author (Bunge 1974: 64 ff) has proved a theorem stating that axiomatization ensures semantic closure. That is, the referents of the logical consequences of a set A of statements in an axiomatic system are the same as those of A. The corresponding practical rule is: "Start by listing your basic (primitive) concepts, and stick to them and their logical combinations." However, semantics deserves a section of its own.

2. Semantics

Aristotle taught us that the very first thing we should state when starting a talk or a text is what it is about – its referent(s) or denotation. For instance, when using the predicate 'hypocrite' we can only refer to a person. The way to find out the referent(s) of an expression is to identify its leading predicate, analyze it as a function, and note the latter's domain. For example, kindness (K) is ordinarily predicated of human beings (H), so that $Dom\ K = H$. And the values of the function K are propositions such as "Eve is kind". Calling P the set of all such propositions, we analyze K as the function that maps the domain H into the codomain P, or $K: H \to P$. In short, the reference class or denotation of K is H, or $R(K) = H$.

In other cases the domain may be a set of couples, triples, or in general n-tuples. For example, the proposition "The position of point particle p relative to the reference frame f, at time t and in unit u equals the triple of real numbers <*x,y,z*>", may be symbolized as "*Position* (p, f, t, u) = <*x,y,z*>. The reference class of "position" is then R (position) $= P \cup F$,

where $\cup$ designates the union of sets, P the set of point particles, and F that of reference frames, such as labs and gyroscopes.

Besides knowing what a text is about we want to know what it affirms or denies about its referent(s)– that is, the text's sense, intension or connotation. Consider, for example, the predicate 'good' as said of a teacher. Intuitionists philosophers like G.E. Moore have claimed that it is intuitable but unanalyzable, in particular undefinable. However, students, parents and school inspectors know that a good teacher is one who is competent, clear, kind, patient, punctual, and so on. In other words, 'good', as applied to teachers, is the set of the predicates occurring in the previous sentence. Finally, the *meaning* of a construct (concept or proposition) C may be defined as its referent together with its sense: $M(C) = \langle R(C), S(C)\rangle$.

As for truth, contrary to vulgar opinion, it comes in at least five different kinds, among them formal and factual. The logical and mathematical propositions may be formally true or false to some extent but, since they do not refer to factual matters, they have no factual truth. Correspondingly, whereas formal truth-values are found by analysis, the assignment of factual truth-values requires empirical operations like observation and measurement. For example, "2x3=6" is formally true, as can be checked by adding 3 and 3. By contrast, "Steel feels colder than wood" is factually true, as can be checked by touch as well as by measuring the corresponding specific heats.

It is often said that Kant's distinction between analytic (or *a priori*) and synthetic (or *a posteriori*) judgments is the same as Leibniz's between truths of reason and truths of fact. I submit that the two pairs are similar but not identical, for whereas Leibniz focused on the referents of propositions, Kant was mainly interested in the mode of acquisition and their test for truth.

The status of the geometrical statements is a case in point. At the times of both Leibniz and Kant, the theorems of Euclidean geometry could be taken to be at once rational and factual, or both analytic and synthetic, since it applied to both abstract triangles and their pictures. Hence it could be argued that the theorems in question are synthetic *a priori*. However, read the next sentence.

The terms of this debate changed two centuries later, when Einstein argued for the radical difference between the mathematical geometries, which are many and refer to abstract objects, and the physical geometry, which is single (presumably Riemann's) and concerns concrete objects such as triangles made of three intersecting light rays. Still, in this case it can be argued that, whereas Riemann's original statements are truths of

reason, the corresponding physical interpretations in terms of light rays are truths of fact and, more precisely, synthetic *a prioris*. The same would apply to gravitational waves, positrons, neutrinos, and other things that were observed long after they were hypothesized. So, yes, there are synthetic a prioris. But it is inconvenient to use this locution because the predicate 'synthetic' is not well defined.

Finally, what is the ontological status of the mathematical objects: are they sensa, intuitions, material objects, or fantasies? Arguably, they are law-abiding fantasies – just as fantastic as cartoon characters, but meeting strict definitions or laws rather than behaving capriciously like the irascible Donald Duck.

3. Ontology: facts and things

Ontology, or godless metaphysics, deals with the real world and its constituents and transformations. For instance, Lucretius's *Ex nihilo nihil* is a postulate of any materialist ontology. Paradoxically, it contains the concept of nothingness, though of course it does not reify it. Since nothingness or non-existence is only a concept, it plays no role in a reist (or thingist) ontology like the present one. If there were no things, there would be no facts either since, by definition, a fact is either the occurrence of at least one thing in a given state, or a change of something from one state into another. Thus, the occurrence of ice in the Arctic is a fact, and the melting of a piece of ice, which is a process, is another fact.

We describe facts by means of propositions or diagrams that we assign truth-values on the strength of observations or calculations. Examples: "That glass contains a piece of ice," and "That piece of ice is melting." The last statement may be restated as "That piece of ice is undergoing the solid-liquid change of state." If more precision is needed, we carry out the required empirical operations, and end up stating propositions like the following ones

Temperature of p at time $t_1 = 0°\text{C}$, or $\text{T}(p,t_1) = 0°\text{C}$
Temperature of p at time $t_2 = T_2 \,\&(T_2 > T_1)$

In the preceding, T designates a function that maps the set M of material things cross (Cartesian product) the set of temperature units into the interval of real numbers. If we choose the Kelvin scale, that interval starts at 0, whereas the Celsius scale starts at -273°C. The choice of scale is conventional, but it need not be absurd or inconvenient. In some countries the Fahrenheit scale, along with inches and ounces, is still used

outside the scientific community. In any case, the temperature unit must always be indicated, so that, as stated above, $T\colon M{\times}U \rightarrow \mathbb{R}$, which comprises all the statements of the form "$T(m,u) = r$," with $m \in M$, $u \in U$, and $r \in \mathbb{R}$, where $\mathbb{R}$ names the real line.

4. State space

So far we have dealt only with properties in themselves. When dealing with empirical data we must say so explicitly – for instance, when giving a temperature difference measured with a Beckmann thermometer or a thermocouple. That is, the domain of the previous temperature function will be expanded to include the measurement technique.

Let us collect all the n known properties of a specimen of matter into the set P, out of which we construct the list or ordered n-tuple $<P1, P2, ...Pn>$. This list can be thought of as a vector in the n-dimensional Cartesian space S spanned by that vector. This vector is called the *state vector*, and correspondingly S is the *state space* of the said material thing, because the tip of the vector represents the state of the thing at a given time. As time elapses, the state of the thing changes, and the state vector moves in the state space, which of course is the set of all the possible states of the thing. The reader is invited to draw a diagram representing the successive states of an idealized thing characterized by only two properties, such as position and momentum, pressure and temperature, or income and spending.

In other words, the *really possible facts* or occurrences involving a given thing are representable as so many points in a state space for the thing in question.

And since the concept of real possibility is ontological, it overflows logic, which is concerned with concepts and propositions. Hence the very concept of a modal *logic* as a theory of possibility regarded as the predicate calculus enriched with a possibility operator, symbolized as a diamond, is ill conceived. Modal logics are about propositions, not facts, hence they cannot double as ontologies – except of course in an objective idealist philosophy. Only factual disciplines, like physics, sociology and engineering, are competent to define the various concepts of possibility – physical, social, technological, and so on.

The concepts of state and change of state allow one to define that of *history* of a thing as the succession of its states, or the trajectory of the tip of its state vector in its state space. This trajectory is *random* only if every state is assigned an objective probability; otherwise it is said to be *causal*. If the events in question depend upon the states of a perceiving animal, we

are in the presence of an appearance or *phenomenon*. Thus appearance is not opposed to reality: it is just the tiny bit of reality perceived by an animal. Incidentally, it is impossible to craft a state space of an immaterial mind, for this is a qualitative concept.

An entity is said to be *objectively real*, or to exist really, if it is changeable. I posit that all and only material objects are changeable (Bunge 1981). Thus, numbers are imaginary but their names, namely *numerals*, such as the signs 'three', '3' and '|||', are objectively real because, being inscriptions on paper or stone, they are subject to change, even utter destruction. Thus, the predicates "real," "changeable," and "material," are coextensive (apply to the same objects) even though they are not cointensive (do not have the same attributes).

The preceding definitions characterize at once the materialist ontology and the realist epistemology. In both conceptual systems, predicates are concepts, whereas properties are traits of either conceptual objects, like numbers, or material objects, such as the signs that represent them.

Finally, a concrete or material *system* may be defined as a complex thing, that is, a thing with two or more components or parts. But composition is only one of the key features of a system. Further traits of it are its *structure* (or set of relations among its parts) and its *mechanism,* or process that makes it what it is. For example, anatomists study the structure of animals, whereas physiologists study the mechanisms that characterize them, such as their metabolism, development, reproduction, and ecology.

Systemism is the ontological hypothesis that all objects, whether real or imaginary, are either systems or components of such. And the thesis that all real things are material, may be called *systemic materialism,* adumbrated by Holbach in his influential if heavy tomes *Système de la nature* (1770) and *Système social* (1773).

Lastly, the probabilities involved in the above definition of randomness are objective, thus unrelated to the vulgar concept of subjective (or Bayesian) probability. Whereas in everyday life we usually employ the latter, in the factual sciences and technologies we should only use objective probabilities, which quantify objective possibility. It is licit for different people to assign different subjective probabilities or likelihoods to a given event, but in science it is desirable to assign every *random* event a single objective probability (see Bunge 2012).

Our concept of materiality as changeability allows for a plurality of types of matter, from tangible bodies and subtle fields to the quaint entities studied by quantum physics, astrophysics, cosmology, and the nonphysical sciences such as chemistry, biology, and social science. And, as we saw in

the previous chapter, physical space qualifies as material. Although at first sight this view is paradoxical, it is not more so than the vulgar notion of space, according to which it is the nothingness that includes everything, or the nonentiy that contains all entities.

5. Biophilosophy

We may define 'living' (or 'alive') as anything capable of metabolyzing. Materialists have always held that eventually living cells would be synthesized in the laboratory. In 1922, the Russian chemist Alexandr Oparin reported on the earliest findings in this ambitious project. The latest result, published in 2017, is the synthesis of the chromosome of the yeast used in manufacturing beer (Kannan & Gibson 2017). No one doubts that further findings will follow, and that what is being learned in the process will be used in designing new therapeutics.

A *biospecies* is a set of living things with a common immediate ancestor, the same metabolism, and similar relations to their environment. Being sets, biospecies are not concrete entities; but, since they have precise defining properties, they are not arbitrary assemblages. In contrast populations, or collections of conspecifics, are material things, differing only in their geographic location. For instance, the gray foxes that inhabit both sides of the Southern Andean mountain range belong to the same species although their habitats, hence their diets, are slightly different.

Different concepts of a biospecies have of course been proposed, but I submit that only the one sketched above has been used in biology. Another, just as troublesome, concept in biology is that of goal or purpose, which was ridiculed by François Rabelais, Francis Bacon and others at the beginning of modernity, and rendered unnecessary by evolutionary biology. To be sure, the word persists in the literature, as when it is said that the *purpose* of wings is flying, or that wings, which had originally emerged as display organs, were later *repurposed* as airfoils. I submit that the purpose concept has a legitimate place in animal psychology, but that in biology "goal" should be replaced by "*specific function*." Thus the heart does many things, but its specific function is to pump blood, and the specific function of a school is to teach.

A possible definition of this notion in biology is this: "The specific function of the part (organ or structure) S of the organisms of species B is the process that only S can go through" (Mahner & Bunge 1997). As suggested above, the specific function of an organ may change in the course of evolution. For example, it has been conjectured that wings

developed originally for non-flight "reasons" or functions, such as cooling, egg brooding, gliding, or display (Brusatte 2017).

The chief practical dividend of evolutionary biology is perhaps the use of animals in the testing of drugs. This common practice assumes that rats, Guinea pigs, cats and simians are kin to us, so that what works for them may work for us too.

6. Medical philosophy

Although most medics are so overworked that they have hardly time to read any philosophy, actually they practice a number of philosophical theses while treating their patients. For example, they waste no time doubting the existence of their charges or the reality of their illnesses; when diagnosing any medical trouble, they bypass both induction and deduction, and proceed to crafting one or more hypotheses compatible with the bulk of their medical knowledge; and when recommending a treatment, they try to make use of the latest findings described in medical journals.

For example, if a patient complains of painful chest cramps his physician does not believe that this condition is but a social construction invented by the medical community, as a constructivist like Bruno Latour would claim He first tries expanding the esophagus, a procedure that is bound to bring immediate relief; but if the cramps persist, he may consider that the oesophagus is a hollow muscle just like the larynx, whose cramps are prevented by a known relaxing drug; finally he remembers having read a paper recommending a certain pill for larynx cramps, and decides to try it on his patient with esophageal cramps. This idea turned out to be correct: the cramps did not recur, so there was no need to resort to the traditional methods, namely expansion and longitudinal surgical incision. The methodological moral is, of course, that some analogies are fruitful or at least painless.

Whereas traditional treatments, like bed rest and fasting, were found by trial and error, modern drugs, like penicillin, were designed, manufactured and tested by scientific procedures. The most interesting of these is RCT, short for randomized controlled test, also used to test mass-produced articles like light bulbs. The fulcra of RCT are the comparison of two populations of items of the same kind (the target and the control ones), and the random selection of the members of the control batch. The former fulcrum was introduced in 1865, and the latter as recently as 1949. Unsurprisingly, RCT has been harshly criticized by philosophers of the "structuralist realist" persuasion; predictably, scientists have ignored these

criticisms. The present author (Bunge 2013) has argued that, while RCT is the gold standard, its combination with a detailed description of the drug's mechanism of action provides the *platinum standard.*

7. Philosophy of mind

A scientific and up to date philosophy of mind will take psychoneural monism for granted, i.e., it will assume that everything mental is neural. Hence it will also assume that the psychosomatic processes, such as the bowel movements caused by intense fear, do not illustrate the power of mind over matter, but are cases where cortical processes act on lower-level processes. In other words, the modern philosophy of mind is attuned to cognitive neuroscience, both individual and social – which in turn may help develop psychology as the neurosociological science of behavior and mind.

Three of the myriad accomplishments of this approach are the demystification of the placebo effect, the acceptance of free will, as well as the admission of conceptual creation beyond the combination of percepts, as in the invention of the zero, the wireless, and the modern cooperatives conglomerate.

One of the philosophical conundrums solved by the scientific philosophy of mind is the difference between explanation by causes and explanation by reasons – a difference elided by the use of the ambiguous 'be*cause*' and exacerbated by mind-body dualism. Indeed, the materialist will argue that au fond there is no difference, because every explanation by reason(s) is a process in the neocortex, hence a causal chain. Thus invoking reasons to explain a fact, as when explaining it in terms of law statements, is basically a neural process described in impersonal terms, as when Newton explained Kepler's orbits in terms of gravitation and inertia.

Lastly, whereas the brainless psychologies are technologically impotent, the brain-centered ones have inspired neuroengineering, to which we owe neural prostheses that replace some of the lost motor parts of the brain. One such artifacts allows quadriplegics to move mechanical arms allowing them to write and feed themselves. These devices sound like science fiction, for the patient wearing them can move things around by just imagining them. Again, they do not exemplify the power of immaterial mind over material things, but the power of one part of the brain over another. In contrast, none of the brainless psychologies favored by idealist philosophers can possibly inspire such marvels.

The preceeding does not imply endorsing radical reductionism, such as the formula "You are your synapses," which the eminent Joseph Le Doux (2003) opposes to the vague notion of self, which in classical psychology

is kin to the equally fuzzy concepts of soul and person. Indeed, although synapses (or interneuron bridges) are for real, mental processes occur on the much higher level of neuronal systems of networks, such as the ones including the amygdala, the organ of fear.

8. Epistemology

Epistemology, or the theory of knowledge, analyzes the general concept of knowledge (and ignorance), and asks about the peculiarities of ordinary, scientific, technological, moral, and philosophical knowledge. Epistemology is of course a member of the philosophical triad: ontology, epistemology, and practical philosophy. And it can be either descriptive, normative, or a mixture of the two. Normative epistemology, also called 'methodology', is concerned with such notions as evidence, scientificity, and pseudoscience.

The vulgar definition of knowledge as "justified belief" provides a useful albeit ephemeral starting point. To start off, it involves the reduction of epistemology to psychology, since beliefs are mental states, whereas knowledge, unlike cognition, is tacitly assumed to be impersonal – that is, valid for everyone even if found or invented by only a few outstanding individuals unafraid of counter-intuitive and even unpopular ideas, such that inventing a concept consists in the formation of the corresponding neuron assembly, as Donald Hebb imagined in the mid-twentieth century.

Every piece of knowledge is the outcome of a cognitive process controlled by an epistemic community such as that of the students of gravitational waves. People outside this community may hold different opinions, or unjustified beliefs, of such processes, and some of them may turn out to be true. True beliefs are rare, particularly in politics, where big lies can win many votes – whence the name of the "post-truth era" for the period starting with the 9 -11 tragedy. But of course lies are likely to have always been used by politicians, long before they had to face public opinion. For instance, antisemitism was used in medieval times to demonize, expropriate and exclude wealthy Jews.

Some of the most exquisite pieces of knowledge, for instance about black holes and the habits of desert-dwelling insects, have been acquired just to quell curiosity, and the market worshippers discredit the whole enterprise of seeking disinterested knowledge as a waste of time and money. But the sciences are rich systems that may stagnate or even collapse if one of their components is neglected. Besides, no one can foresee whether a given piece of basic or disinterested knowledge may

turn out to be useful after all. Remember the case of vanilla, one of the 30,000 or so orchids attached to the barks of rare tropical trees. Whereas the shortsighted politicians and economists demand the production of patents, not learned papers, the systemists will tolerate, nay encourage, the search for new knowledge of all kinds. Utility will come, if at all, as a byproduct of truth.

Pragmatists urge us to always seek utility, and they fail to distinguish tests for truth from tests for utility. But in the advanced technologies we need both because, by definition, advanced technology is a byproduct of disinterested science. Businesspeople are interested in testing new artifacts for productivity, user-friendliness, and so on. But artifacts are designed using pieces of knowledge whose applicability no one foresaw.

For example, the inventors of quantum physics did not foresee that this piece of knowledge would eventually be used to design our computers; and the early geneticists could not predict that medicine would end up by using genetics to either cause or prevent mutations leading to cancerous growth. Giambattista Vico, an early Romantic, who held that we can only know what we make ourselves, would be amazed to learn that we may never know perfectly a human product such as set theory or quantum physics.

The scientific stance is skeptical rather than dogmatic. But scientific skepticism is partial, not total like philosophical skepticism (Bunge 2000). Indeed, we doubt a novelty only if it is inconsistent with a tried piece of our background knowledge. This is why the scientist asks around for constructive criticism: he wishes to repair, not to demolish. This is why scientists abide by the old maxim "If it ain't broke don't fix it."

For example, factual scientists do not question mathematics: they take it for granted while questioning the factual assumptions of a theory. Likewise, chemists do not question the physical assumptions they use, and biologists do not question chemistry. The same strategy does not work in social science, because some biological processes in humans, from feeling to perception, thought and decision, are strongly influenced by social factors such as exclusion and competition.

Scientific skepticism starts at the level of perception. Indeed, scientists do not regard all sense data as more reliable than hypotheses, and they are prepared to admit counter-intuitive results. Take for instance the light going through a transparent medium. Common sense is likely to take it for granted that a light beam will travel along the shortest distance. This is indeed the case for homogeneous media, but light will bend at the border of two media with different refractive indices, such as 1.000 for air, and 4/3 for water. The real trajectory of light is the one of least possible times, not least distances.

The above-mentioned conjecture about least times was first stated by Pierre Fermat (ca.1650), who raised it to the rank of principle. Fermat's principle could not have been obtained by observation if only because, in his day, time measurements were not precise enough. But it is a consequence of Huygens' wave theory of light, which preceded the observations that confirmed it. The reason that high-level hypotheses cannot be crafted out of empirical data is that the latter do not involve the theoretical concepts characterizing the former – for example, the concept of refractive index. The data handled by geometrical optics, which refers to light rays, contain only distances and angles. The very notion of light propagation is absent from that theory, hence so is the formula "$v = c/n$," where v represents the phase velocity and c stands for the velocity of light in vacuo. Both v and c occur in wave optics but, again, they do not occur in the experimental data relevant to that theory.

All this explains the severe limitation of induction, or generalization of observational data. By the same token, it explains why neither empiricism nor pragmatism nor naive realism can give true accounts of high-level science. Only scientific (or sophisticated) realism is consistent with high-level science (Mahner 2001)

9. Methodology

Methodology, or normative epistemology, deals with the methods or rules of procedure used in scientific research. Suffice to mention only three of them: the hypothetico-deductive one, the randomized controlled trials, and replicability. The latter consists in the condition of possible replication of experimental results, so as to exclude rare coincidences derived from either defective experimental designs ("artifacts") or the confirmation bias of the experimenter. There is currently much talk of replicability crisis in experimental psychology and biomedical research.

When most scientific papers in a given field turn out to be false, as Ioannidis (2005) and others showed to be the case in biomedical science, a radical methodological revision is called for. The neuroscientists Jeffrey Mogil and Malcolm Macleod (2017) suggested that researchers should be allowed freedom of exploration in the initial phase, but that before submitting a paper for publication, their central hypotheses should undergo a more rigorous final test perfomed by an independent body of colleagues such as a different laboratory or a consortium. By 'more rigorous' they mean adopting a higher threshold of statistical significance, such as $P < 0.01$ instead of the current $P < 0.5$.

In short, "Be tolerant at the beginning, but severe when seeking final confirmation" – a necessary condition for publication. Adopting this strategy "would slow the rate of publications, but not the pace of discovery." I would add that, even before the initial exploratory phase, the hypothesis to be tried out should show promise by its compatibility with the bulk of antecedent knowledge (Bunge 2017).

10. Axiology and praxiology

Axiology is the study of valuation, an operation that is performed in all the stages of scientific and technological research, from problem choice to the examination of methods to the weighing of results. Irrationalists hold values to be intuitive. By contrast, rationalists demand the justification of values. For example, we look for truth out of honesty, but we don't necessarily wish to maximize truth, for in many cases approximate truths, such as ballpark estimates, suffice.

From a scientific viewpoint, values do not exist by themselves, but are constructed and defended or attacked by individuals, either individually or collectively. This entails that values change along the course of history. For instance, until recently simplicity was regarded as a necessary trait of scientific constructs. This is no longer so: if a scientific result is simple in some regard on top of being true and interesting, so much the better, but the history of science, technology and philosophy is one of increasing complexity, so that the old adage *Simplicity is the seal of truth* is false (Bunge 1963).

For example, contemporary genetics is far more complicated than Mendel's. For one thing, it is far deeper, for it goes beyond morphological traits, down to their molecular roots. Suffice it to remember that cancerous growths are attributed to genetic mutations, and that genetic editing can prevent the occurrence of certain diseases. This reminds us that depth is one of the desirable features of epistemic novelties.

Let us finally deal with a classical axiological problem: the so-called fact/value chasm. Consider the difference between an unsatisfactory state of affairs, such as the difference between women's and men's wages for the same work. It can be argued that this difference is just a trait of the gender discrimination occurring nearly everywhere. Hence correcting such an inequality is just jumping over a ditch rather than flying over a deep chasm.

In other words, closing the fact/value gap starts by admitting that David Hume was right in noting the difference between statements of fact and value judgments, but wrong in claiming that such a gap is unbridgeable, since the whole point of action is to close the desirable/existing gaps. That

such an operation is often hard to accomplish, is another matter– though often one of either brute force or technological ingenuity.

11. Social philosophy

Any serious political philosophy starts with a social ontology, or a view on the nature of the social, as different from the individual. There are several views of this kind, and every one of them may be regarded as a solution to the individualism-holism-systemism trilemma. Individualists hold that there are only persons; holism, that social totalities are unanalyzable; and systemists, that every social system is analyzable into its composition, structure, and mechanism.

Individualism is the simplest and most fashionable social ontology, for it denies the existence of social wholes such as families, schools, and firms, all of which are characterized by impersonal, global, or emergent properties, such as justice, stability, and profitability. For example, an organization is just only if what its members give it is worth roughly the same as the benefits they derive from their participation in its travails.

This explains why most people put up with exploitation, or even slavery, in exchange for security, which in turn provides with protection, roof, and food. This explains the bloody Canudos war, waged in NE Brazil in the late 1880s against the abolition of slavery: the freed slaves were suddenly left without secure shelter and food, and at the mercy of the market, which needed them only at the times of planting and harvest, which took only half a year. The former slaves were now free to die of hunger or exposure the rest of the year.

Whereas individualists focus on leaders and their interests and decisions, holists emphasize masses and supraindividual entities and processes, such as industrialization, democratization, and mass literacy as the chief modernization mechanisms. But holists also claim that individual interests and ambitions must submit to supposedly higher values such as national pride and glory, which are often nothing but disguises for the greed of the power elites, starting with the top boss. However, in addition to this authoritarian version of holism, there is the communitarian and naive one, which emphasizes solidarity to the point of claiming that the chicken should be able to live along with the fox in the same coop. The blunt fact is that solidarity without equality and liberty is at best well-meaning charity, which in turn presupposes inequality.

Finally, social systemism is the view that every person is a member of several social systems, such as family, gang, business, club, church, or party. Thus, systemism makes room for both individual initiative and

social responsibility, and explains mass phenomena, such as migrations, wars and cultural movements, that defy both individualism and collectivism (more in Bunge 1989, Wang 2011).

The epistemological counterpart of social systemism is the program of social anthropology, social psychology, and economic sociology: all these disciplines try to explain the social by the individual and conversely. For example, President T acts like a spoiled child because he had a privileged upbringing, never was under any obligation, and was taught that making money is the ultimate desideratum – which, after all, is what the contemporary ethos of the wealthy boils down to.

12. Ethics

Morality is the field where individual wishes and rights collide with social duties or burdens. For example, my right to enjoy a public garden is constricted by my duty not to damage it. Further, there are objective moral facts, such as crime and ethnic discrimination. Such facts generate problems whose solutions call for both personal commitment and collective action. This is why all social systems devise or adopt moral norms whose essential role is that of protecting the status quo.

Traditional moral philosophies are indifferent to social issues. Only social ethics tackles problems such as what to do in social emergencies such as tsunamis, tropical hurricanes, nuclear meltdowns, prolonged droughts or floods, plagues, civil wars, or international conflicts. Neither Buddhism, nor the Ten Commandments, nor Aristotle's virtue ethics, nor pragmatism, nor negative utilitarianism ("Do no harm") can guide us in these cases, when isolated individuals can at most set good examples.

In tradition-bound groups, moral norms are expected to be observed without discussion. In contrast, in a scientific perspective we want to make sure that such norms "work," that is, that they solve the corresponding moral issues. In turn, this view suggests that moral norms, far from being adopted dogmatically, be subjected to experiment (see e.g. Ingenieros 1917, Bunge 1989, Appiah 2008).

Every ethical doctrine has a basic norm, which all the other norms are expected to observe. For example, the basic norm of utilitarianism is "Thou shalt maximize your (or your group's) expected utility." This is of course nothing but selfishness, which cannot work because everyone needs the help of others, either directly or through impersonal actors such as the state and NGOs.

In other words, we should devise moral philosophies where personal and social virtues reinforce one another. I submit that agathonism, or the

pursuit of the good, fits this bill because its top maxim is *Enjoy life and help others enjoy it.*

Top maxims suffice in ideologies where they function like slogans, but not in scientific ethics, which is expected to handle every moral issue in the light of the best relevant knowledge. Consider for instance the ethical issues raised by new technologies such as CRISPR or gene therapy, which in principle allows us to spot and alter genes *in utero*, in particular those causing disabling diseases. Like all technologies, this one is ambivalent: it can be applied to either prevent diseases or to breed docile workers, like the ones imagined by Aldous Huxley in his prescient albeit frightening *Brave New World* dystopia of 1932.

However, gene therapy is not unique: all new technologies are ambivalent because they are means, and all of them are worth being discussed rationally and in the light of both the best current knowledge and a humanist top ethical principle. Thus the practical solution to the ethical problems raised by new technologies is found in politics, not in scholarly venues – which shows that ethics, unlike logic, cannot be pursued in isolation from politics.

13. Legal philosophy

The goal of legal philosophy is to analyze and evaluate the laws of the land. Since laws come in systems or digests, the legal philosopher's task is to study and evaluate digests (Martino 2014). In performing this task, legal philosophers have adopted either of these doctrines: natural law (e.g., Albert the Great, Thomas Aquinas, Thomas Hobbes), legal positivism (e.g., Hans Kelsen, Carl Schmitt, H.L.A. Hart), and legal realism (e.g., Oliver W. Holmes, Roscoe Pound, A. V. Lundsted).

The unscientific nature of the natural law school is obvious: the very expression 'natural law' is an oxymoron, for legal precepts are man-made, they come with society, and are subject to change. Legal positivism too is unscientific, for it boils down to conformism, or support of the status quo regardless of the rights, needs, and aspirations of the citizenry (Fuller 1958).

Only legal realism fits in with the scientific attitude, as it starts with social realities, only to evaluate them in the light of both social science and ethics. For example, legal realists will challenge oppressive regimes because they impose privileges and thus generate the unhappiness and resistance of the many. By the same token, legal realists will support all the reforms that expand personal liberty while increasing the burden of social responsibility, as well as the protective functions of the state.

I submit that only legal realism is consistent with the scientific stance, because it assumes that, far from being an autonomous domain, the law is made and altered in intimate contact with sociopolitical realities, and can be perfected with the help of the social sciences and philosophy, in particular ethics (Bunge 1998).

14. Political philosophy

Politics has two sides: the contentious or struggle for political power, and the constructive or management of political organizations. The tasks of political philosophy are to account for both governance and contentious politics, to rescue the state from both libertarianism and statism, and to note the superiority of science-based policies over populist improvisations.

The most famous political slogan in modern history is the *liberty-equality-fraternity* triad introduced by the 1848 French revolutionaries: they understood intuitively that none of the members of that triad works without the other two. Systemic philosophers will explain why. They will also explain why that political triad must rest on the *jobs-health-education* tripod: because (a) liberty can flourish only among equals; (b) every individual needs the assistance of others; and (c) the sick, unemployed and uneducated citizens are prey to demagogues.

The critical political philosopher will be skeptical about traditional movements such as unregulated capitalism and parliamentary socialism. He will remind the reader that entrepreneurs need both the rule of law and the protection of a state ready to bail them out in hard times; and that authentic socialism involves transformations so radical, that they are unlikely to be carried out through rational debate and democratic vote alone – whence the uselessness of both Jürgen Habermas's deliberative democracy and John Rawls's impartial calculation.

This is why real socialism has never existed: the so-called Nordic socialism is actually controlled capitalism, and the so-called authoritarian socialism is a contradiction in terms, for genuine socialism involves power sharing instead of dictatorship. I submit that genuine socialism equals cooperative property cum voluntary participative governance (Bunge 2009, 2018).

The reader must have noticed that the political philosophy sketched above rests on a systemic ontology and a realist epistemology. This is why it is at odds with simplistic recipes like anarchism (both leftist and rightist), liberal democracy, managed democracy (or oligarchy), and orthodox Marxism (or dictatorship of the self-proclaimed vanguard of the working class). Since the traditional ideologies are bankrupt, let us try and invent

new ones, in particular real democracy based on social science and ready to listen to the verdict of praxis (see Bunge 2017c).

15. Sciences of Religion

The scientific approach has been applied to many religions of since about 1900. As a consequence we now have four sciences of religion plus the philosophy of the same: the psychology, sociology, politology and history of religion, each one with its scholarly journal.

However, we still need a thorough study on the use of religion as a covert political tool, the way Aristotle and Machiavelli saw it. The American President Eisenhower learnt this trick in the nick of time: he got himself baptized twelve days after his inauguration, and ordered the new official motto of the USA to be *In God we trust* – to which some joker added: *All others pay cash*.

The politology of religion might yield the following results among others. The authors of the Bible claimed that the murders it tells about were commanded by God; the Crusades were actually looting and land-grabbing expeditions whose soldiers were incited by the battle cries *Deus vult* (or *Dieu le veut*) and *Nobiscum deus* (God is with us); the European colonization enterprises were about mines, land and slaves rather than the attempt to shower heathens with the gifts of the true religion; the Thirty Years War was over land, not religion, as suggested by the fact that the bulk of the Catholic armies were Lutheran mercenaries, who took double delight in looting the Vatican; the Eighty Years War between Spain and the Netherlands was over Flemish artworks and tapestries, not over biblical hermeneutics; Islamic Turkey fought alongside Christian armies in the Crimean war as well as in both World Wars; the Nazi banner was headed by the old Prussian motto *Gott mit uns*; the Cold War was over world domination, not religion; the Jewish fanatics who occupied Palestinian land claimed that Abraham had given it them two millennia earlier; and Saudi fanatics are currently conniving with Israeli Jews and American evangelists against Iran. In short, a scientific look at the history of the religion-politics connection would reveal many an embarrassing hypocrisy.

Lastly, a few words about the philosophy of religion, which can be secular or religious. If the latter, that is if it takes its own assertions to be so many articles of religious faith, it does not belong to modern philosophy. But if the discipline is secular, it may start by attempting to define the concept of religion – for example, as a body of statements about supernatural beings inaccessible to scientific scrutiny. In this case, the

discipline cannot be approached scientifically, so that it falls outside the purview of this book. However, this does not render it uninteresting or beyond debate. But such curiosity and debate are unlikely to yield new knowledge: the otherworldly is not a subject of scientific research.

16. Scientific Philosophy and the Philosophy of Science

Scientific philosophy and the philosophy of science are close, but they are distinct if only because their referents are different. Indeed, whereas the philosophy of science refers only to science, scientific philosophy can refer to anything, even to pseudosciences such as homeopathy and psychoanalysis, as well as to antisciences such as phenomenology and existentialism.

For example, a scientific approach to ancient Greek philosophy might dismiss some of it while exalting other predecessors. To begin with, some of the pre-Socratic fragments hardly make sense to us. Thus, Parmenides' most famous sentence "What is, is," is at best ambiguous, and in any case it does not fit modern logic, for it involves no subject, contrary to "What moves, moves", which is just a truism of the form "If A, then A." In general, when reading the pre-Socratics we should remember that, as Guido Calogero warned me, theirs was babbling rather than distinctive speech. And when they wrote artworks, like Plato's dialogues, they often uttered falsities or even nonsense, as Karl Popper (1945) and David Stove (1991) pointed out.

Still, some pre-Socratic discoveries were both clear and important. Let the following sample suffice: love for logical consistency; explicit mention of the universe of discourse (or objects referred to); identification of materiality with mutability; medicinal force of nature (immunity); equality before the law; and abhorrence of tyranny – though not of slavery, torture, or war.

Historians of philosophy have discovered many nuggets in our philosophical heritage, but they have tended to ignore some absurdities, as well as that the neo-Platonists, the late schoolmen, Kant, Hegel, Wittgenstein, or even Russell made no lasting contributions to our understanding of the real world. Granted, today's scientific philosophers, like everybody else, build on the past, but they can safely ignore practically all of it, particularly Engels' neo-Hegelian dialectics, Nietzsche's nihilism, Bergson's intuitionism, Husserl's egology, Croce's idealism, Heidegger's nonsenses, Wittgenstein's glossocentric aphorisms, subjective probability games, David Lewis's possible worlds semantics and metaphysics, and all the French self-styled neo-Marxists. None of them has helped advance

science or society; they have only presented philosophy as idle speculation. However, a few contemporary scholars have written clearly on important subjects. As well, some of the earlier publications on important philosophical concepts, such as those of category, emergence, evolution, level of organization, possibility, probability, chance, time, system, value, liberty, justice, test, mathematics, and objectivity.

While a few results of philosophical research are definitive, most philosophical problems are still open, particularly when seen in a scientific light. For instance, Augustine of Hippo might be as puzzled as pleased to learn that free will, once ridiculed by scientists, is currently a subject of experimental psychology. But no one should be surprised to learn that time, though no longer mysterious, is still posing intriguing questions, such as whether duration is the property of some thing, whether it is single or multiple, had a beginning and has a direction, and whether its clip depends on matter. Augustine would certainly be shocked to learn that philosophy is now detached from theology but has become entangled with science to the point that what is a given for one of them is a problem for the other. And he would be perplexed or even disgusted by the very expression 'scientific philosophy', whereas Aristotle, for whom Augustine did not care, might reply that he had not even thought of the question, since he had always thought of knowledge as a single whole.

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